THE TELEGRAPHIC JOURNAL AND

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THE COST OF PRIVATE ELECTRIC LIGHTING.

ALTHOUGH accounts have been published from time to time giving the results of a year's working of this or that electric light installation, the data on which the estimate of cost has been based, have not always recommended themselves to men of business, who have generally managed to perceive a loophole for an attack in one direction or another; and in the majority of instances the commercial instinct has proved itself correct. The user of electricity who fondly believes he is illuminating his residence not only in a better but in a cheaper way than he would have been able to do with gas, gradually inclines, much against his will, to the views of the man who brings incontrovertible figures to prove his case; but he consoles himself with the fact that his annual bill for decorative repairs will not be worth mentioning, and that he has at least secured a pure atmosphere in his rooms. There are instances, however, in which we think, given an installation of sufficient magnitude and perfection of design, it can be shown that electricity not only holds its own but is in reality cheaper than a gas supply.

It is generally known that Sir David Salomons has one of the best appointed electric light plants in the kingdom, and also that he has very carefully entered into the question of cost for several years past, so that any figures coming from him may be looked upon as approaching as near to absolute accuracy as is possible. Happily, we are in possession of a few facts concerning his experience which we will lose no time in placing before our readers.

The plant consists of boilers, engines, dynamos, and secondary batteries, equivalent to a maximum of 1,000 20-C.P. lamps, with the numerous switchboards and other adjuncts attached to a large installation. The buildings in which the plant is erected are very substantial and well fitted, and the total cost of the installation has been about £6,000, or much the same as a gasworks to do the same work; perhaps the latter would have been more costly. The sinking fund in both cases would be much the same, but the working expenses of the electric light have proved more favourable than gas. This statement is made authoritatively, for there were private gasworks at Broomhill before the electric light was instituted. It was at one time a question between building larger gasworks or adopting the new light. Calculations decided in favour of the latter, and practice has proved the wisdom of the choice which was made. There is a book kept of every penny spent on the light, as well as the number of ampère hours used. This cost-book has been accurately kept for the past three years, and runs thus:—For 1884 the total outgoings amounted to £165, being at the rate of 2d. an hour for every 20 C.P. lamp; in 1885 the expenses were £181, or 1¼d. per hour per 20 C.P. lamp; the total expenses in 1886 were £210, being at the rate of ½d. per 20 C.P. lamp. The expenses include wages, coal, oil, waste, washers, repairs, lamp renewals, &c. A six cubic feet gas burner costs ¼d. an hour when gas is sold at 3s. 6d. per 1,000 cubic feet, so that in 1886 the electric light proved far cheaper than its rival would have been had private gasworks been used. The reason why the expenses went up in each year, and at the same time the economy increased, is:—Firstly, as confidence in the electric light increased it was used more and more, and finally without stint, so that the installation was gradually worked nearer the point of greatest economy; and, secondly, numbers of improvements were introduced, in the way of management as well as apparatus, which led to satisfactory results. About £2,000 were expended on experiments before the present stage was reached, but this year Sir David expects to economise still further by a reduction on his coal account, due to some improvements which have been effected, and he hopes by this means to go as low as $\frac{1}{10}$d. per 20 C.P. lamp. Below this he does not expect to get, as wages and other items, which need not be specified, cannot be reduced.

RECENT ADVANCES AND IMPROVEMENTS IN THE APPLICATION OF ELECTRICITY TO RAILWAY WORKING.

TYER'S TRAIN TABLET SYSTEM.

(*Continued from page* 25.)

Method of Working.—We will now assume that we have a section of line (Y Z) provided with the necessary apparatus at either point, and that we have a train standing at Y which is required to proceed to Z.

The instruments at both ends of the section indicate that the tablets are *in*, and consequently that the line is clear.

The first proceeding is for Y to inform Z of the approaching train; this is done by certain bell signals —2, 3 or 4 beats, according to the description of train, whether passenger, goods, mineral, &c. Z will acknowledge this by repeating back the number of beats received. So far nothing has been done to interfere with the locking arrangements of the apparatus; but it is now necessary that Y should obtain a tablet to let the train proceed. He therefore gives to Z on the bell the "train tablet signal," say five beats, which Z acknowledges by one beat on the bell.

Immediately on receiving this acknowledgment Y depresses his bell plunger (J, fig. 1), and keeps it down till his galvanometer needle falls back to zero. This tells Y that Z is turning his lower disc, whereon he immediately depresses his switch plunger (I, fig. 1), and holds it down until the upper disc of his instrument shows the signal tablet "out." He then relieves the switch plunger, lifts up the check ring (K, fig. 1), and draws out the slide (D, fig. 1), from which he obtains the tablet. On its receipt he announces the fact to Z by one beat on the bell, which is repeated in acknowledgment when he gives the tablet to the driver and the train proceeds.

In the meanwhile it will be understood that Z on observing his galvanometer needle deflected has turned

his switch, A, one-quarter round until his lower disc has indicated the word "out," and that then by the depression of his bell plunger for a space of about three seconds he has, with the combined action of Y, enabled Y to withdraw a tablet from his instrument.

The departure signal is now given by Y, and repeated by Z in acknowledgment.

Upon the train arriving at Z the engine driver gives the tablet to the signalman, who raises the receiving instrument lid (C, fig. 1), and inserts the tablet. He then gives the arrival signal to Y, which is acknowledged by a repetition of the signal. Y then presses down, and keeps down, his switch plunger until his upper disc indicates tablet "in."

In the meanwhile, immediately on receiving the acknowledgment of the arrival signal, Z turns his switch (A, fig. 1), to produce the signal tablet "in," and again depresses his bell plunger for the space of three seconds. Y is now able to push his slide (D, fig. 1), home. He does so, and announces the same to Z by one beat on the bell, which is acknowledged by repetition when the transaction is complete and the indications on both sets of instruments are restored to "train tablet in."

The instruments are bold and massive in character, and the workmanship of the several parts is carried out in that accurate and thoroughly finished manner for which Messrs. Tyer & Co. are so well known.

The system is in use on the Caledonian, the Port Patrick, the Somerset and Dorset, and, we believe, on some other lines, and is highly spoken of.

THE ELIESON ELECTRIC LOCOMOTIVE.

ON the afternoon of Thursday, the 20th inst., we had the pleasure of witnessing a practical demonstration of the advantages claimed for electric locomotion as exemplified in Elieson's system of tramcar propulsion. Some long time since we accompanied the inventor on a trial trip during the initial stage of his experiments, and in the REVIEW for December 5th, 1885, we gave a fully illustrated description of the apparatus employed, together with the impressions which a critical examination of the system suggested.

Since that time improvements in detail have been effected in the locomotive, and seven more locomotives have been built by the Electric Locomotive and Power Company, of 6, Great Winchester Street, London. Six of these engines are intended for working the traffic on that portion of the North Metropolitan Tramway Company's system already referred to. The reason why they have not yet been started on the work is that the Electric Locomotive Company has not yet obtained the Act which will give the necessary running powers. This Act passed the second reading in the House of Lords last session, and only awaits the reassembling of Parliament to be put through the final stages. In the meantime, and pending the passing of the Act, the company has permission to run the engine over the line every Thursday afternoon with a loaded tramcar.

On this occasion we have only to chronicle a most unqualified success, the action of the machinery being perfect and, as the *Times* has it, only one opinion can be expressed upon the practical efficiency of this method of traction.

A number of gentlemen, including the Earl of Galloway, Lord Sackville Cecil, Sir W. Thomson, Mr. John Pender, Sir James Anderson, the Marquis of Tweeddale, George Richardson, Esq., chairman of the North Metropolitan Tramway Company, Mr. Magnus Volk, and Mr. Perry Nursey, were present at a trial trip which must have afforded the most lively satisfaction to the directors of the Electric Locomotive and Power Company. Previous to starting, Mr. Elieson was for some time occupied in explaining to interested groups of engineers the construction of his secondary battery and the action of the electric machinery in the locomotive. *En passant* we will here observe that for tramway purposes the Elieson secondary cells appear to be most admirably adapted.

It has been truly remarked that tramway working is somewhat rough, and secondary batteries that will do splendidly as fixed batteries carefully placed on substantial supports in a building might be completely wrecked with a day's jolting and jarring in an ordinary car on the common street tramway. The secondary battery for this work must be not only a highly efficient battery electrically, but it must be strong mechanically. It must be capable of standing a good deal of hard work without the breakage of its electrodes or the detachment of the active materials therefrom. Such a battery, to all intents and purposes, is that used in connection with the North Metropolitan experiments, for the inventor took apart a set of plates which formed one cell and bent and twisted them out of recognition; in the same manner they were straightened and fitted together again in the twinkling of an eye. There being no paste employed, the extraordinary manipulation which these plates can undergo without detriment to their capabilities is the more readily understood. This part of Mr. Elieson's system will be more fully explained in another issue, although we can now state that there are 11 plates in each cell, and each plate consists of a grid of lead 8 inches by 9 inches and about $\frac{1}{4}$ inch thick, and perforated with a large number of square holes. In each of these holes is placed a small coil of lead foil and asbestos paper. As the plates form the coils swell and fix themselves tightly in their seats. The total area of the lead strips is 1,800 square inches, thus affording a very large surface available for oxidation within the limited area of a plate only about 9 inches square. It has been found from experience that the batteries improve in power by use, and that when the plates have been worked for some time as negatives the current can be reversed and they are then in the best condition for forming positive plates. The cells are charged at the tramway depôt at Stratford, where there is a 25-horse semi-fixed engine by Marshall, of Gainsborough, which drives two Phœnix dynamos. When the cells require replenishing the locomotives will be run into the yard and the accumulators recharged with the current to their *maximum* capacity.

Between 3.30 and 4 o'clock a locomotive was attached to a tramcar, which, by the way, was of the ordinary kind and without any additions or alterations, and with a complement of some 60 passengers, we started from the yard of the North Metropolitan Tramway Company's depôt at Stratford. In the yard is a curve of 27 feet radius, and in leaving the gates for the main thoroughfare is another of 60 feet radius. These were successfully passed over at a slow speed, and once in the street we commenced the journey to Manor Park, Ilford, a distance of about $2\frac{1}{2}$ miles.

During the trip we had to journey along gradients, the chief of which are 1 in 27 and 1 in 32, and on these we were stopped and started again without the least difficulty. The traffic in the street was considerable, which to us seemed very advantageous, for we were thus enabled to observe how thoroughly Mr. Elieson, who was driving, had the car under control.

After stopping a few minutes at Manor Park, where the car and passengers were photographed, the return trip was commenced, and during this Mr. Elieson, at the wish of several of the party, demonstrated how quickly the car, when running beyond the regulation speed, could be brought to a standstill, the motion reversed, the car backed, and a fresh start made, all these manœuvres being accomplished in the most perfect manner.

The total weight of the locomotive is 6 tons 8 cwt., and that of the tramcar, empty, 2 tons 14 cwt., or, with its full complement of 46 passengers, 5 tons. But on the occasion of the actual run there were about 60 passengers on the car and engine, so that the total weight moved was in excess of 12 tons.

The cells in the locomotive numbered 90, and when running a voltmeter showed 170 volts E.M.F. The

current varied from about 55 ampères at starting to 25 when running on the level, and probably the average current throughout the trip would be fairly represented as of 30 ampères. The weight of each cell is 76 lbs. complete, and its capacity 150 ampère-hours. They are usually charged at the rate of 40 ampères, but can be safely charged at 60, and they have been in daily use for seven months.

The motor is a kind of hybrid machine, having field magnets of the earlier Siemens type, and a "Phœnix" armature by Paterson and Cooper. The speed is regulated by means of resistances which can be inserted and cut out of the circuit at pleasure, and Mr. Elieson's reason for the employment of this somewhat wasteful method of regulation is that he can thereby obtain a nearly constant discharge from his batteries.

For further technical details of the system we must refer to the number of the REVIEW mentioned above, in which the method of gearing adopted by Mr. Elieson is made perfectly clear. As far as practice goes, there should be as little likelihood of a breakdown in an electric system of haulage as with horses, and we must frankly admit that an accident to the very substantial gearing of the Elieson apparatus is most unlikely, however quickly the car may be brought to a standstill. Doubtless it has been thought in many quarters that the bodily rotation of the motor when running was an objectionable feature; but, on account of the simplicity of the gearing and its easy yielding to jolts when they occur, combined with the great strength of all the parts, the only conclusion at which we can arrive is that Mr. Elieson has given a most successful solution of a problem, the difficulty of which we fully appreciate.

Respecting the question of cost, we think it can be demonstrated without a shadow of doubt that the electrical haulage of tramcars can be accomplished at a cost of less than 4d. per car mile, and if it is desired we shall be pleased to make known the data on which we base this estimate. A special feature in the economy of the Elieson system appears to us to lie in the secondary batteries, the depreciation on which, from their peculiar construction, should not amount to half that charged against those in whose manufacture paste is employed.

It does not appear to be without the bounds of possibility that these cells would last for tramway purposes for several years, and then be set to work as stationary batteries for electric lighting or other work. On the whole, we think that no praise is too high for the Elieson method of electric locomotion, and every other inventor must wish it success, for that once assured, the path is open to all.

TRANSMISSION OF POWER IN SPAIN.

A COMPANY called the "Electro-Dynamic Association of Carsi, Mari & Co.," has been formed in Valencia, with the object of utilising water power to be obtained at the Falls of Chulilla on the River Turia, situated at a distance of 56 kilometres from Valencia.

It is proposed to erect the generating machines at the village of Torizuilla whither the water power will be conducted by a subterranean canal of 1,762 metres and an open one of 741 metres. It will be also necessary to construct dams, sluices, flood gates, accessory canals, turbines, &c.

Observations have shown that the power obtainable varies from a minimum of 2,000 H.P. in summer to a maximum of 3,500 in winter. The experiments lately effected by Mons. Fontaine with Gramme machines resulting in the transmission of an industrial return equal to 52 per cent. of the original force, have encouraged the company to rely upon an effective working power of at least 1,000 H.P., which will be used for public and private electric lighting, and as motive power for various descriptions of machinery.

The company proposes to charge 25 centimes per horse-power hour, which is considered by our contemporary *La Electricidad*, of Barcelonas, much too low a rate, comparing this tariff with the price of 70 centimes per horse-power hour charged by a Paris company over a limited district for transmission of motive power by means of compressed air. It is also pointed out that gas costs per horse-power 60 centimes.

The daily expenses connected with the working of this undertaking are calculated as follows:—

Interests, mortgages, and repairs,	francs	784
Administrative staff	„	87
General working „	„	91
Electrical „	„	144
Workshop „	„	29
Guards, watchmen, and caretakers	„	20
Various	„	76
Total daily expenditure ...	francs	1,231

Against this the company puts its daily receipts at 4,888 francs, or a daily profit of 3,657 francs. We are not given much information as to the details upon which the receipts are calculated, but it is evident that the company bases its revenue on the supposition that the whole of the available power will be taken up. Our contemporary points out that of the 1,000 H.P. exerted at the receiving machines, the consumers will certainly not be able to make use of more than 60 per cent.

ELECTRIC LIGHTING OF THE COLONIAL AND INDIAN EXHIBITION.

DETAILED TECHNICAL REPORTS—*continued.*

Continued from page 49.

APPENDIX A.

Showing Number of Lamps, Lamp Hours, and Energy Expended for Approximate Area in Square Feet, of each Section, together with the Total Failures of Lamps.

BUILDINGS.

SECTION.	Full number of lamps.	Average number of lamps.	Hours burning.	Lamp hours.	Watts, from switchboard.	Approximate area in square feet.	Watts, per square foot.	Total failures.
I.	436	409	600	245,400	25,272	13,800	1·83	172
II.	99	80	600	48,000	4,558	2,380	1·9	148
III.	284	284	600	170,400	20,395	16,000	1·27	82
IV.	252	207	600	134,200	13,707	10,500	1·3	135
V. ... ... { 1	204	204	600	122,400	10,044	6,480	1·5	60
{ 2	116	116	475	55,100	5,580	3,500	1·6	15
VI.	212	132	600	79,200	7,198	5,500	1·3	72
Total	1,603	1,432	...	...	86,754	59,160	1·4	...

SUBWAY AND CELLARS.

SECTION.	Full number of lamps.	Average number of lamps.	Hours burning.	Lamp hours.	Watts, from switchboard.	Approximate area in square feet.	Watts, per square foot.	Total failures.
VII.	35	35	1,920	67,200	7,200	30,837	·2	30
	56	56	600	33,600				18
	102	95	2,058	195,510	8,800	17,450	·5	255
	55	49	626	30,674				11
Total lamps ...	1,851	1,667	...	1,197,684	102,750	106,447	·9	998

The average failures from all causes were 1 in every 1,200 lamp hours.

APPENDIX B.

Showing Lamps of different Voltage, Lamps of different Makers, Details of Failures, Percentage of Failures for the Approximate Number of 600 Hours.

SECTION.	Number and description of lamps.	Failures of lamps. In filament centre.	Failures of lamps. In joint of filament.	Failures of lamps. In capped lamps.	Failures of lamps. By accident.	Total number of failures.	Hours burning.	Average hours per lamp.	Percentage of failures per 600 hours. Electrical.	Percentage of failures per 600 hours. Accidental.	Old or new lamps.	REMARKS.
I.	114, 96 v., E. S.	19	10	...	6	35	600	465	25·4	5·2	New	These lamps were supplied this year.
	67, 96 v., Edison	9	...	...	3	12	600	528	13·4	4·5	Old	These lamps were run throughout the Inventions Exhibition.
	25, 96 v., E. S., Edison Screw	13	5	7	5	30	600	272	100·0	20·0	New	Supplied this year.
	156, 48 v., E. S.	15	20	...	20	55	600	443	22·4	12·8	New	These lamps were supplied last year, but were not used.
	26, 96 v., Edison	10	...	...	...	10	600	427	34·8	...	Old	Old lamps from the Health and Inventions Exhibitions.
	17, 96 v., E. S.	3	2	...	...	5	600					
	28, 96 v., E. S.	3	4	...	...	7	194	155	77·0	...	New	New lamps this year.
II.	72, 48 v., E. S.	30	56	...	5	91	600	...	133·3	14·5	Old	Old lamps from the two last Exhibitions.
	24, 48 v., E. S.	28	16	...	9	53	434					
	3, 96 v., Edison	1	...	1	...	2	166					
III.	284, 60 v., Victoria	40	...	35	1	76	600	473	26·4	0·4	Old	These lamps were supplied last year, and were run for about 320 hours.
IV.	129, 100 v., W. & R.	8	12	...	10	30	600	486	15·5	7·7	Old	These lamps were run about 500 hours last year.
	35, 100 v., Victoria	60	...	...	6	66	600	207	171·4	17·0	Old	These are old lamps.
	63, 50 v., E. S.	12	5	...	...	17	600	497	27·0	...	Old	Lamps from last Exhibition.
	13, 96 v.	10	...	...	2	12	600	405	40·0	8·0	Old	Old lamps from the Health and Inventions Exhibitions.
	12, 100 v.											
V.	204, 46 v., E. S.	40	6	...	11	57	600	468	22·5	5·3	Old	These are old lamps which have been running through the Health and Inventions Exhibitions, and there are about 23 lamps still good, which have been running since the Fisheries Exhibition. This year they were run from 4 to 6 volts lower than their proper voltage.
	116, 46 v., E. S.	9	...	...	4	13	450	404	9·9	4·4	Old	
VI.	125, 96 v., E. S.	28	10	...	17	55	600	416	30·0	13·4	New	New lamps supplied last year.
	62, 96 v., E. S.	2	...	...	1	3	118	...	16·0	8·0	New	New lamps this year.
	25, 96 v., E. S., frosted	3	...	...	2	5	118	...	60·0	40·0	New	New this year.
VII. (Subway)	27, 80 v., E. S.	6	3	1	2	12	1920	1329	11·4	2·3	New	These lamps were supplied last year, but not used.
	10, 80 v., W. & R.	10	2	...	3	15	1920	764	36·0	9·0	Old	Old lamps run last year.
	2, 42 v., W. & R.	1	1	...	...	2	1070	535	...	...	Old	Old lamps run last year.
	34, 80 v., E. S.	4	...	...	2	6	600	510	11·0	5·9	New	Supplied last year, but not used.
	18, 100 v., W. & R.	6	3	...	3	12	296	...	100·0	32·0	Old	These are old lamps run for about 500 hours during the Inventions Exhibition, and also for about 390 hours in the Cellars at the beginning of this Exhibition.
Cellars I.	45, 100 v., W. & R.	6	4	...	18	28	390	...	27·8	...	Old	These are old lamps from the Health and Inventions Exhibitions.
	48, 50 v., W. & R.	43	...	...	5	48	450	...	115·0	...	Old	
	56, 55 v., E. S.	18	...	...	10	28	1243	...	16·0	...	Old	
Cellars II.	44, 50 v., W. & R.	10	5	5	5	25	199	...	135·0	...	Old	
	44, 48 v., W. & R.	30	18	...	...	48	286	...	216·0	...	Old	
	58, 50 v., E. S.	42	16	...	10	68	598	...	100·0	...	Old	
Club Offices	68, 100 v., E. S.	1	2	...	1	3	620	...	16·0	...	New	Lamps supplied this year.
	37, 100 v., W. & R.	4	1	...	1	6	620	...	19·0	...	Old	Old lamps run 500 hours last year.

APPENDIX C.

Showing Fourteen Day's Readings of the Quadrant Battery, Charge and Discharge in Ampère Hours.

Date.	Charge from Dynamo.	Discharge to Lamps.	Charge left in Battery.
Oct. 11	1,416 amp. hours	840 amp. hours	576 amp. hours
„ 12	1,416 „ „	840 „ „	576 „ „
„ 13	1,316 „ „	840 „ „	476 „ „
„ 14	1,358 „ „	840 „ „	518 „ „
„ 15	1,442 „ „	840 „ „	602 „ „
„ 16	1,344 „ „	840 „ „	504 „ „
„ 18	1,323 „ „	798 „ „	525 „ „
„ 19	1,299 „ „	840 „ „	459 „ „
„ 20	1,330 „ „	924 „ „	406 „ „
„ 21	1,239 „ „	840 „ „	399 „ „
„ 22	1,288 „ „	840 „ „	448 „ „
„ 23	1,201 „ „	840 „ „	361 „ „
„ 25	1,324 „ „	798 „ „	526 „ „
„ 26	1,310 „ „	840 „ „	460 „ „
	18,606 amp. hours	11,760 amp. hours	6,846 amp. hours

Showing 63 per cent. in ampère hours, with a fall in electromotive force of 6 volts for 5 hours' discharge of about 160 ampères.

APPENDIX D.

Showing Energy Generated and the Difference between Charging and Discharging Accumulators, in Watts.

ELWELL-PARKER DYNAMO.—QUADRANT BATTERY.

10.15 a.m. to	11.15 a.m.	...	141 volts	...	176·1 amp.	= 24,830 watts
„ „	12.15 p.m.	...	142 „	...	180·5 „	= 25,631 „
„ „	1.15 „	...	144 „	...	180·5 „	= 25,992 „
„ „	2.15 „	..	144 „	...	180 5 „	= 25,992 „
„ „	3.15 „	...	144 „	...	180·5 „	= 25,992 „
„ „	4·15 „	...	144 „	...	180·5 „	= 25,992 „

Average, 25,738 watts = 34·5 electrical H.P. per hour.
Difference in watts made use of in lamp circuit, 16,224 watts = 21·74 electrical H.P. per hour.

EDISON-HOPKINSON DYNAMO.—SUBWAY BATTERY.

10.15 a.m. to	11.15 a.m.	...	142 volts	...	211·6 amp.	= 30,047 watts
„ „	12.15 p.m.	...	142 „	..	190·5 „	= 27,051 „
„ „	1.15 „	...	143 „	...	213 „	= 30,459 „
„ „	2.15 „	...	143 „	...	213 „	= 30,459 „
„ „	3.15 „	...	142 „	...	180 „	= 25,560 „
„ „	4.15 „	...	137 „	...	180 „	= 24,650 „

Average, 28,036 watts = 37·6 electrical H.P. per hour.
The total electrical H.P. developed was 72·1 H.P., while the engine (No. 1) driving these dynamos indicated at the time the above readings were taken, 109·5 H.P.

II.—ARC LIGHTING.

For lighting all the Courts, 423 arc lamps, driven by 26 dynamos were employed, which were divided, according to contract, into three sections.

Section I.—Anglo-American Brush Electric Light Corporation, Limited.

In this section three 40-light Brush machines, with old type of armature, were employed to drive 32 Brush lamps, each (new type) of from 9·5 to 10 ampères, and 48 to 50 volts; one machine of the same description was kept as a reserve. There were also three 20-light machines, with laminated armatures, driving 20 and 22 lights, and one machine in reserve.

Of these machines there is no failure to be recorded, beyond the necessity for changing one armature, owing to faulty insulation.

	Number of Lamps.	Approximate Square Feet.	Square Feet per Lamp.	Average. Ampères.	Average. Volts.	Watts, per Sq. Ft.	Lamp Hours.	Lamp Hour Failures.	
South Promenade	18	80,000	4,444	9·75	50	·1	10,764		Outside Lighting
South Court	21	25,420	1,210	„	„	·46	12,558		Inside „
Middle Court	40	40,000	1,000	„	„	·48	23,920		„ „
North Court	22	30,000	1,363	„	„	·35	13,156		„ „
Front Entrance	6	8,900	1,483	„	„	·33	3,588		„ „
Duval Dining Room ...	6	7,200	1,200	„	„	·4	3,588	7	„ „
Eastern Arcade									
Eastern Gallery	55	64,400	1,170	„	„	·41	32,890		„ „
Maltese Court									
Hong Kong Pavilion ...									
Kitchens	2	2,000	1,000	„	„	·48	1,196		„ „
Total	170	257,920	1,090	9·75	50	·44	101,660	7	

The total area inside the buildings lit up by the Anglo-American Brush Corporation was 177,920 square feet, for which 162 arc lamps, taking 487 watts each, were employed.

The average square feet per lamp = 1092
„ „ watts per square foot = ·44
„ „ square feet per watt = 2·22

Section II.—Messrs. R. E. Crompton & Co.

To light this section 10 machines of the Bürgin type, driving 140 Crompton lamps of from 14 to 15 ampères and 50 volts each, were employed, and two were kept as spare machines.

Most of these machines had at first Crompton armatures, but owing to their frequent failures they were exchanged for armatures of the Bürgin type. The total failures recorded are 25, of which 17 were in the armatures.

	Number of Lamps.	Approximate Square Feet.	Square Feet per Lamp.	Average. Ampères.	Average. Volts.	Watts, per Square Foot.	Lamp Hours.	Lamp Hour Failures.	
Water Pavilion	4	6,270	1,567	15	50	·47	2,392		Inside Lighting.
Canadian Court	26	34,750	1,336	„	„	·57	15,568		„ „
Central Annexe	9	12,400	1,377	„	„	·46	5,382		„ „
East and West Central Courts...	45	55,200	1,226	„	„	·6	26,820		„ „
South Central Court	12	17,000	1,416	„	„	·52	7,176		„ „
Conservatory								600	
Quadrant B. Bar	24	45,400	1,891	„	„	·39	14,352		„ „
Lower Tea Gardens									
South and East Basins	18	103,540	6,090	„	„	·11	10,764		Outside „
Map of the World									
Engine House	2	...	...	„	„	...	1,196		
Total	140	274,560	1,961	15	50	·38	83,650	600	

The total area inside the buildings lit by Messrs. R. E. Crompton & Co. was about 171,020 square feet, for which purpose 120 arc lamps of 750 watts each were employed :—

Average square feet per lamp = 1416
„ watts per square foot = ·52
„ square feet per watt = 1·9

Section III.—The Pilsen-Joel and General Electric Light Company, Limited.

To light this section six dynamos of the Schuckert type were employed, driving 113 Pilsen lamps, each lamp taking from 9·5 to 10 ampères and 46 volts ; two Schuckert dynamos were held in reserve. Of these machines nine failures were recorded from all causes, five of them being in the armatures.

	Number of Lamps.	Approximate Square Feet.	Square Feet per Lamp.	Average. Ampères.	Average. Volts.	Watts, per Square Foot.	Lamp Hours.	Lamp Hour Failures.	
West Arcade	52	67,450	1,297	9·5	46	·34	30,996		Inside Lighting.
West Gallery									
West Annexe									
Cape Court	29	45,100	1,555	„	„	·28	17,342		„ „
Grill Room...	3	1,800	600	„	„	·73	1,794		„ „
Machinery Bar	4	5,200	1,300	„	„	·34	2,392	10½	„ „
Outside	1	...	...	...	...	...	598		Outside „
Quadrant A. Bar	8	9,600	1,200	„	„	·36	4,784		Inside „
Engine Shed, and	9	10,200	1,020	„	„	·42	5,980		„ „
Passages	1								
West Canadian Section	6	14,500	2,413	„	„	·18	3,588		Outside „
Total	113	153,850	1,361	9·5	46	·3	66,574	10½	

The total area lit by the Pilsen-Joel Electric Light Company within the Exhibition buildings was about 139,350 square feet, for which purpose 106 arc lamps were employed :—

Average square feet per lamp = 1302
„ watts per square foot = ·32
„ square feet per watt = 2·9

APPENDIX.

Phœnix Fire Office, 19, Lombard Street,
London, E.C., 9*th Nov.*, 1886.

To the Electric Lighting Committee,
Colonial and Indian Exhibition.

Gentlemen,—The Colonial and Indian Exhibition having now reached its close, I am instructed by the Phœnix Fire Office to say, that they cannot sufficiently express their sense of obligation to your committee for the fact, that notwithstanding the electric light installations have been on a scale of magnitude never hitherto reached—that they have been running under circumstances of peculiar difficulties and danger, due especially to the vast amount of inflammable materials in their vicinity, and the immense throngs of people who have crowded the Exhibition—yet not a single instance of electrical fire has occurred in any of the buildings, nor even an alarm of such fire. How different would have been the result had there been the slightest error of judgment or relaxation of supervision, the Phœnix Fire Office are aware—possibly a conflagration and destruction of life almost unparalleled.

I am also desired by the Phœnix Fire Office to ask you to thank on their behalf Mr. J. H. Cundall, your electrical engineer, for the skill and unremitting care with which he has carried out every matter connected with the safety of the installation.

I am, Gentlemen, yours faithfully,
(Signed) MUSGRAVE HEAPHY.

Musgrave Heaphy, Esq. *Nov.* 10*th*, 1886.

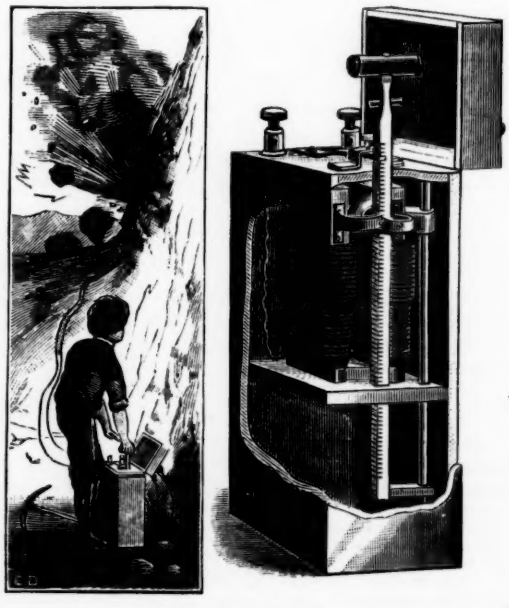
Dear Sir,—The Electric Lighting Committee of the Colonial and Indian Exhibition desire to express to the Phœnix Fire Office, through me, the great satisfaction which your letter of the 9th inst. has afforded them. In congratulating themselves upon the success which has attended the electric lighting, and upon the immunity from even the most trifling alarm of fire in the Exhibition buildings which they have enjoyed, they recognise to the fullest extent that this success and the freedom from accident are in a very large measure due to the skill and unremitting care of their engineer, Mr. J. H. Cundall, and they are also highly sensible of the value which your suggestions in reference to measures of safety have been to them.

The Committee have had much pleasure in communicating to Mr. J. H. Cundall the well-merited thanks of the Phœnix Fire office.

I am, dear Sir, yours faithfully,
(Signed) F. A. ABEL.

DYNAMO-ELECTRIC IGNITING MACHINE.

IT is well known that the field magnet and armature of a small dynamo-electric machine may be quickly



brought to saturation ; and that when the current is at its maximum, the breaking of the circuit will cause the extra current generated in the coils to be discharged, either through the air at the point of rupture

or through a derived circuit connected with the terminals of the field magnet. In the machine here illustrated this fact is taken advantage of, and also the fact that an accelerated motion of the armature is more effective in bringing the field magnet and armature to magnetic and electric saturation than a uniform rotation of the armature. The field magnet and armature —which is preferably of the Siemens I type—are of the usual construction. Mounted upon that end of the armature shaft opposite the commutator is a pinion, with which engages a rack bar passing through the top of the casing supporting the machine and extending downward toward the bottom. The upper end of the bar is provided with a handle, between which and the top of the casing a pin is inserted in the bar and allowed to project a short distance upon each side.

When the handle is raised in operating the machine, the pinion is rotated on the shaft without turning the armature, the clutch connection between the pinion and armature permitting of this action. When the rack bar is pushed down, a quickly accelerated rotary motion is imparted to the pinion, and the armature is rotated between the poles of the field, generating a current, which is so conducted that very little of it passes through the external or derived circuit, on account of its comparatively low electromotive force and the high resistance of the circuit. The current increases rapidly as the rack bar descends, and charges the armature and field to saturation. Just before the bar reaches the limit of its travel, its pin strikes a spring key secured to the top of the casing, and breaks the electrical connection at the instant the maximum of current and of magnetisation of the field magnet is reached, so that the extra current flowing from the winding of the field and armature is compelled to pass through the external circuit, and thus heat the wires of the fuses included in that circuit, causing their explosion. The high electromotive force of the extra current enables it to readily pass through the external circuit, whose great resistance prevents the passage of the normal current.

This invention has been patented by Mr. H. Julius Smith, of Mountain View, N.J.—*Sc. Am.*

AN IMPORTANT ELECTRIC LIGHT INSTALLATION AT A COTTON MILL.

ONE of the largest, if not the largest, electric light installations at a cotton mill has lately been completed in an important cotton manufacturing district. The extensive cotton mills of Messrs. Rhodes and Sons at Hadfield, near Manchester, have now been lighted by electricity instead of gas for a period of a little over a month, and last week an opportunity was taken by the Manchester and District Edison Electric Light Company—which carried out the installation in its entirety —of inviting a party consisting of gentlemen connected with the cotton and other industries to inspect the mills under the recent change of its system of lighting. The complaints relative to the quality of the gas, and also as to other points with respect to the lighting, led the Messrs. Rhodes to the opinion that a change in the mode of illumination would be for the better, and after the satisfactory inspection of various mills already lighted by electricity, they determined to abandon the use of gas and employ electricity instead, and the contract for the whole of this important installation was given to the Manchester and District Electric Light Company, which has during the past four years carried out in this district numerous and extensive electric light installations.

The mill contains 73,566 spindles and 1,300 looms, and is now lighted by nearly 1,500 incandescent lamps, instead of the 2,000 gas jets formerly employed. The lamps are Edison-Swan 16 candle-power fixed in brass sockets and covered with a white porcelain shade. There are eight circuits in all, and the mains and leads are carried in boarding; a plentiful provision has been made with regard to safety fuses, whilst switches are fixed to each room. The switches are specially mounted in slate, and the main switchboard in connection with the dynamo controls the various circuits by the "plug" arrangement, that plan being considered more advantageous in the present instance.

The current is obtained from two Edison-Hopkinson dynamos, driven by a horizontal engine specially manufactured for the purpose of this installation by Messrs. Mather and Platt, of Salford. The two dynamos are each capable of an out-put of 44,000 watts, equivalent to 750 lamps (110 volts, 400 ampères), at 620 revolutions per minute. They are of the latest Edison-Hopkinson type, with the length of field magnets still further reduced, and bar armatures. The commutators are built up of 47 bars of copper, insulated with mica, and are readily detachable from the armature. There are three brushes on each rocking arm, each separately adjustable with spring forward thrust and hold-off catch. The armature bars have a section of 0·106 square inch, and hence the load is 3 ampères per square millimetre. The dynamos are compound-wound, but owing to the great strength of the magnet field and small disturbance caused by the armature, 12 convolutions of series coils is sufficient to secure perfect compensation for the whole range. The following are the particulars of the resistances :—

Armature	...	...	...	0·00645 ohm.
Series coils	...	...	...	0·0013 „
Shunt coils	...	...	...	17·4 „

An electrical efficiency of 96 per cent., and a commercial efficiency of from 94 to 95 per cent. is stated to have been obtained from these dynamos.

The engine is high pressure, condensing, with a single cylinder, 23 inch diameter, 30 inch stroke, intended to run at 100 revolutions per minute, and to work with a boiler pressure of 80 lbs., and under these conditions will indicate about 170 horse-power.

The cylinder is carried on an independent stand, and bolted to the trunk or frame, which is of box section, and supported at the crank end on a separate foot. Both the cylindrical slide and the crank bearing pedestal are in one piece with the trunk. The piston rod and crank pin are steel, and the connecting rod best hammered scrap. At the crosshead end the connecting rod is forked, and the wear taken up by a wedge and screw; its length is three times the stroke. The crank is of the disc form, and is shrunk and keyed on to the shaft; the crank pin is also shrunk in. The shaft is 8 inches diameter, bossed up to 8½ inches for the flywheel, and at the crank end is carried in a bearing 15 inches long, and at the off end, in an angle pedestal, fixed in a wall box, 12 inches long and 6½ inches diameter. The main bearing is adjustable both top and bottom and at the sides by wedges and screws, so that the brasses can be fixed in any way while the engine is at work. The flywheel is 12 feet diameter and 27 inches wide, and is prepared for two 12-inch belts. It was cast whole, split and bolted together at the rim, and held with bolts and shrunk hoops at the boss; its finished weight is 5¼ tons. The main and cut-off valve are worked by two eccentrics, having respectively 4½ inches and 5½ inches traverse. The engine is governed by a Porter's governor with steel arms, working on to the throttle valve. All the bearings, the eccentrics, crank pins, &c., are lubricated from one oil tank fixed over the main bearing; and the oil is collected by suitable drippers led into a tank below, from which it is returned to the top tank by a pump. The cylinder is lubricated by Mather and Platt's improved sight-feed lubricator, requiring one plug valve only.

The air pump and condenser are combined. The pump is double acting, worked by a tail rod from the piston, the cylinder being 10 inches diameter, 30 inches stroke, and has two suction and two India-rubber delivery clacks of large area at each end. The air pump and cylinder are all bolted to the same stone, and are also tied together by bolts. Throughout all threads on bolts are fine pitch or gas threads, and in working parts have a nut of ordinary depth, locked

with a thin one, and in addition have a split cotter through the end of the bolt.

The visitors were conducted by Mr. George Freemantle, Secretary, and Mr. J. R. Williamson, Manager of the Manchester Edison Company, over the mill and a through inspection of the new illuminant was obtained, an opportunity being given in the weaving room of seeing gas and electricity side by side, and also the effect on the looms of first one illuminant and then the other. The brilliance of the incandescent lamp as compared with gas was universally remarked.

After a thorough inspection had been made the company adjourned to the offices, and after refreshments had been taken, Mr. W. S. Rhodes said that on behalf of Messrs. Rhodes and Sons he wished to express himself pleased to see them all there that day to inspect the electric light, which they were all aware had been carried out by the Manchester and District Edison Electric Light Company. They had, he might say, over 1,400 lights, and they were extremely satisfied with the result, and he trusted that the visit had been productive of information and of service to them. He could tell them that they had had less complaints and sickness in the mill than in the previous corresponding quarter in the works, and they attributed it to a great extent to the purer atmosphere in the works. There was no sulphur nor smell to injure the health of the most delicate person. They did not regret giving the order, and he believed the light had a great future before it. Mr. H. Rhodes also expressed himself satisfied with the light, and spoke in complimentary terms of the manner in which the contract had been carried out.

The whole of the arrangements of the installation were carried out under the personal superintendence of Mr. J. R. Williamson, the Manager of the Manchester Edison Company, and the satisfactory nature of this installation reflects great credit upon all of those concerned in it. We may remark that this is the largest installation in a cotton mill carried out by this company, the next in order being a 1,000 light installation at the cotton mills of Messrs. Wright, Turner and Co., at Pendleton, Manchester, which was carried out over four years ago, and has been in successful and economical operation ever since.

THE ELECTRIC LIGHT AT PENZANCE.

A "LIVELY" meeting of ratepayers took place at Penzance last Friday night, for the purpose of taking into consideration the desirability of adopting electricity for public lighting purposes. For some time past experiments have been made with the electric light in various parts of the town, and the public having had ample opportunities of witnessing its merits in comparison with those of gas, the Mayor, upon requisition, called a public meeting to discuss the question.

Mr. J. G. UREN, addressing the meeting, observed that it was extremely desirable that any town professing to keep abreast with the times should possess the most effective mode of lighting procurable. All of them would no doubt agree that the present system was something approaching a disgrace; and he made that remark without casting any reflections on the Gas Company, for, after all, the duty of improvement rested with the Town Council. At the present time there were two alternative schemes before them—the adoption of the electric light or the purchase of some new Sugg lamps, and the matter resolved itself into a simple question of pounds, shillings, and pence. In order to efficiently light the town by gas, 150 Sugg lamps would be required, costing something like £2,463 a year. On the other hand 60 arc electric lamps of 1,000 candle-power each, together with the gas which would still be required for some of the back streets, would cost only £814 a year. From perfectly disinterested motives, therefore, and from no feeling of antagonism towards the Gas Company, he moved a resolution to the effect, "That this meeting approves of the electric light being used for public lighting in Penzance, and hereby requests the town authorities to consider the best means of introducing it."

Mr. WILLEY seconded the motion, and a discussion followed of an animated description.

Mr. BRANWELL, chairman of the Gas Company, contended that the lighting of the town by the new Sugg lamps could be accomplished for considerably less than £2,400 a year, and that the electric light had proved a failure in London, Edinburgh, and other places. As they did not want any costly experiments in Penzance, he moved as an amendment, "That the town being under a contract with the Gas Company to light the streets, the present moment is inopportune to desire the Corporation to seek other means of illumination."

Mr. GLASSON seconded.

The resolution in favour of electric lighting was carried by an overwhelming majority, only 12 hands being held up for the amendment.

THE EASTERN EXTENSION COMPANY'S MONOPOLY AND THE PACIFIC CABLE SCHEME.

IN our issue of December 31st, 1886, in an article on the "Pacific Telegraph Company," we adopted a favourable view as to the practicability of successfully carrying out the proposed undertaking. We also quoted some remarks made by the Postmaster-General which coincided with our opinion as to the necessity of duplicating the telegraph communication with Australasia by an entirely distinct route, and through the agency of a competing undertaking, and we intimated that the matter had been seriously taken up by many influential colonists.

As a further proof that a trans-Pacific cable is not only very favourably looked upon by colonial authorities, but is actually regarded as a not very distant possibility, we quote *in extenso* the following article, entitled "Cable Rates," from the *Auckland Weekly News*, dated Wellington, November 13th, 1886:—

"The Premier was interviewed yesterday by the representatives of the Press *re* the cable question.

"Sir Robert Stout said the position of the Government and the Cable Company appeared to be misunderstood. The Government, he said, originally agreed, along with New South Wales, to pay a subsidy to the company of £7,500 a year, on condition that a cable was laid between New South Wales and New Zealand, and the subsidy was to be continued for a period of ten years, and, so far as he could see, no provision was made in the agreement to continue the subsidy after the expiration of that period. On the contrary, he asserts that the agreement implies that the subsidy was not to be continued, as per section 8 of the said agreement. The cost of laying the cable was £300,000; but, at the present time, a similar cable could be put down at a cost of £140,000, or a cable of much superior quality to the present one at £175,000. When first the cable was laid he had no doubt it was right to give a subsidy, as the revenue was not large at the commencement of its working. For instance, in 1876 the amount collected in New Zealand by the Government on behalf of the Cable Company was £4,392, and assuming that the same amount was collected at the other end, that would give the year's revenue as £8,784. In 1877 the total amount collected for the cable would be about £13,472, and in 1879 about £18,192; but in 1881 it fell to £15,612; while for the year 1885 it had risen to about £21,226, which sum did not include the amount of the subsidy. Against this amount is to be placed the sum of £2,000, which is estimated as the cost of working, so that the company received £18,626 for the cable, and in addition £7,500 subsidy, bringing the total profits to £26,126, which was, the Premier argued, a very handsome return, especially when it is considered that a cable could now be laid for £140,000. If the company understood that the subsidy was to be continued, why, Sir Robert asks, did they not see to have a clause to that effect included in their agreement? As a commercial transaction it would be far cheaper for the Government to lay a cable at the estimated cost of £170,000 than to continue the subsidy, because if they only received one half of the revenue that the company now received, it would pay interest and sinking fund, and the expenses of working the cable. If this was done, and the rates reduced, as the Government could well afford to do, there would be a handsome income. Another point to be considered is this: shall the Cable Company maintain a monopoly and charge what increased rates they choose, without a word being said against it? If such a thing was allowed it would place the colony in a most unfair position. Referring to the proposed cable across the Pacific Ocean, Sir Robert Stout thought it would be of far greater advantage to New Zealand to pay a subsidy to this route. The subsidy asked was £10,000, and it was proposed that the Government should be allowed free use for its messages to an amount equal to the subsidy granted. There would, by this route, be very little difference in the rates now charged on the Eastern Extension Company's cable. No doubt the construction of the Pacific cable could not be undertaken at once, but one portion of it could be laid—viz., from Queensland to the North Cape in New Zealand. This portion of the cable could be used until the connecting link with America was completed. So far as he could see, what the Eastern Extension Cable Company wanted was to get New Zealand bound for a lengthened period to subsidise their line, and by this means prevent their giving any assistance to any other proposed route. The point to be considered was, should the colony submit to the dictation of a company that says, unless the subsidy is given, the rates will be increased? By section 13 the company had power to increase the rates when the subsidy ceased, but power was also given to the Government to impose a terminal charge on messages transmitted across the cable, and that course has been adopted by the Government. The fact of the company holding power to raise the tariff shows the necessity of the Government

not being bound in the matter. Sir Robert is of opinion that it would be better for the Press and the telegraphing public to pay the increased rate rather than that the Government should yield to the company; and he failed to see why those who object to protection can ask the Government to relieve them from this small extra charge. The increased cost to the Press would not, he thought, exceed £1,500, and assuming that the same amount of business was done on the cable as last year, the cost directly to New Zealand would be only one-third of last year's receipts; or, in other words, about £3,500. Yet the Government were asked to give a subsidy of £5,000 to pay the public a portion of the cable charges on their messages. He felt sure that if the company kept up the increased rates they would lose by it. In conclusion, Sir Robert Stout said the Government had no vote from Parliament to pay the sum demanded, and the Government decline to pay the subsidy, simply because the company demands it. If the telegraphing public would only look at the question from a colonial point of view, they would recognise that it was inadvisable for a subsidy to be paid."

SOME NOTES ON THE GULF STREAM.

To Columbus may be given the credit of being, though unwittingly, the first to notice the Gulf Stream as a distinct current; for in 1492, when crossing the Atlantic, he noticed its northerly set (this was the first ocean current observation of which we have any record), and again in 1503 he observed the currents in the Carribbean Sea making northwards. Ponce de Leon was the first, however, to localise the actual stream, for in 1513 he made the first voyage through the Straits of Florida and encountered the full force of the current.

The best observer of early days was undoubtedly Dampier, and his observations on the Gulf Stream, made in 1690, and which embrace the chief features of the stream, have been found wonderfully accurate.

Considering how long ago the existence of this current was known, it seems, at first sight, extraordinary that until a comparatively recent date its origin should have remained shrouded in mystery, and have been the subject of the most extravagant theories and speculations. But when one considers that the sources which supply the current and the causes which influence its strength, and to a certain extent its direction, are to be sought for throughout an enormous extent of ocean, and taking into account the want of method and lack of scientific education, roughness and inaccuracy of appliances, and the local character of the observations, which so heavily handicapped the earlier observers, it is no longer to be wondered at that erroneous, and generally exaggerated, ideas on the subject should have prevailed. Among the many theories propounded to account for the origin of the Gulf Stream, the following have, perhaps, been most generally made the subject of discussion:—

(*a*) The volume of the Mississippi, assisted by floods from the various rivers falling into the Gulf of Mexico.

(*b*) The motion of the sun in the ecliptic and its influence on the oceanic system.

(*c*) The effects of temperature, by expanding the water through heat in the Gulf of Mexico and consequently raising its level, thus making it the head water of the Gulf Stream.

(*d*) The difference of specific gravity between the waters in the Carribbean Sea and Gulf of Mexico, and those in the polar regions.

(*e*) Evaporation.

(*f*) The effects of temperature, by unequally heating different parts of ocean surfaces in separate and distinct layers, thus producing a vertical circulation resulting in ocean currents.

(*g*) Action of the trade winds.

(*h*) The equatorial currents, assisted to some extent by the trade winds.

We will now give, so far as our limited acquaintance with the subject permits, a brief *resumé* of some of the arguments employed to controvert the above theories:—

(*a*) The Mississippi pours into the sea less than a three-thousandth part of the body of water known as the Gulf Stream as it passes through the Florida Straits. Falling into the Gulf of Mexico, besides this river, there are the Trinity and Colorado Rivers in Texas, the Rio Grande del Norte dividing Texas and Mexico, and the Santander, Pánuco, Goatzocoalcos and Usumasinta Rivers in Mexico. But all these, with the exception of the Rio Grande del Norte and the Usumasinta are of comparatively minor importance, and the whole lot put together would not make more than another Mississippi.

(*b*) It seems reasonable to suppose that general and variable currents should be produced by this motion of the sun, and that it should affect, according to its position, in some degree the strength, and to a certain extent the direction, of the equatorial current, thus indirectly influencing the Gulf Stream, but the action is so very superficial and comparatively temporary, as to place it out of serious consideration as the cause of a large and constant current.

(*c*) This raising of the level of the water would create a slope with an incline of $\frac{1}{10}$th of an inch per mile, corresponding to an accelerating force of less than the two millionth part of gravity, and capable of creating only a very trifling surface current.

(*d*) If density is to assist temperature in producing ocean currents, the densest water must be at the poles, and the lightest water in equatorial and intertropical regions. Captain Maury argues that the densest, consequently the heaviest, water is in the tropics. If this were the case the effect due to heat would be neutralised and the circulation of currents due to differences of temperature would be prevented; and so long as the two causes were to continue in operation, the current produced would only be equal to the extent by which the strength of one exceeded that of the other.

If the theory that difference of gravity produces the current were correct, we would have a heavy warm undercurrent setting towards the poles, and a light cold surface current making southwards to replace it. This is not found to be the case. We know, moreover, that density at some fathoms below the surface is very nearly the same all over the ocean, and the differences would be too slight in their effect to account for the movement of so large a body of water at the speed at which it is known to flow.

(*e*) The maximum evaporation takes place near the tropics, that is near to the point where the Gulf Stream leaves and flows away from, and not runs towards. If evaporation and nothing else were the cause of ocean currents, we should find the surface water flowing from the Atlantic towards the Gulf of Mexico to replace the water there evaporated.

(*f*) It is well known that, except in a very few and purely local cases, the ocean temperature decreases from the surface to a minimum at the bottom, tropical heat only affecting the surface waters. The experiment which showed that warm water rising from the bottom, and cold and heavy water sinking, thus creating vertical circulation, has been cited as an example, but it is needless to point out that it cannot be justly applied to the case in point. And under these circumstances where the horizontal circulation is so limited in extent, it can be decidedly omitted as a factor.

(*g* and *h*) Quoting from Wyville Thomson's "The Depths of the Sea," we learn that the equatorial current starting from the African coast to the southward of the Islands of Sao Thomé and Anna Bom is driven across the Atlantic by the combined action of the North-East and South-East Trades in one unbroken surface current, 4,000 miles long and 450 miles broad, at a speed of 40 miles in the 24 hours, and at a temperature of 73½° F. This current divides off the South American coast, one part going south, and the other running towards the Carribbean Sea, through which it spreads, passing into the Gulf of Mexico, and finally as the Gulf Stream proper, flowing northwards through the Straits of Florida (pages 380—381, "Depths of the Sea," Wyville Thomson).

Objectors to this theory state that the Gulf Stream proper has not more than a six-hundredth part of the breadth of the parent current when it impinges on the Windward Islands, and that through the Carribbean Sea the currents are variable and comparatively feeble. The first objection is answered by the fact that the equatorial current, though so much larger in surface, has neither the depth nor velocity of the stream as it passes through the Florida Straits, and that a considerable portion passes to the northward outside the line of islands. The second objection appears at first sight to be the more serious, but it must be remembered that the currents in the Carribbean Sea are variable only in the sense of a temporary easterly or westerly deflection due to local winds, and that the main set is always in a northerly direction, and that counter or eddy currents depending on local causes for their direction, duration and strength, must of a necessity be met with. And as to the feebleness of the current, it may be remarked that the main strength of the stream, for the same reasons as have been applied to its direction, will not always be found in the same locality. The equatorial current and trade wind theory, originated by Sir John Herschell, certainly appears to be the most reasonable of the many causes put forward to account for the Gulf Stream.

As we approach the Straits of Florida, where the field of operations is more limited in extent and the observations more numerous, we obtain more precise information as to the character of the stream in that particular locality, nearly all the result of operations conducted by the United States Coast Survey Department. For a *resumé* of those observations we refer our readers to the "North Atlantic Memoir," page 389 *et seq.*, but the results may be briefly summed up as showing, mainly, the narrow and shallow character of the stream as compared with the exaggerated ideas as to its dimensions until recently accepted.

In addition to the observations made by the United States Government Officials, a good deal of valuable, though of course purely local, information has been acquired during the operations connected with the laying of, and repairs to, the submarine telegraph cables which cross the Straits between Cay West and Habana. In 1866 Mr. Hilgard, of the United States Coast Survey, undertook a survey of the Straits between Habana and Cay West in connection with the first cable laid between those points. The results of his operations showed that of the entire breadth of the channel between Sand Cay Light (about six miles from Cay West) and Habana, a distance of 82¼ miles, the Gulf Stream only occupied about 40 miles on the Habana side. He also found that the bottom descended gradually from the Cay West side, that the deepest water was 800 fathoms within five miles of Habana, and that at this depth the bottom temperature was 45° Fahr. He discovered that the depth of the warm stream running northwards was not more than 200 fathoms.

More recent investigations made on much the same line as followed by Mr. Hilgard show that his results are in the main correct, excepting that the deepest water was found to be a little

over 1,000 fathoms at a distance of 18 miles from the Cuban shore, and that the temperature at a depth of 800 fathoms was 39° Fahr. A series of observations made in the stream show the temperatures at various depths to be :—

0	fathoms	84	degrees	Fahr. surface
100	„	76	„	„
200	„	62½	„	„
300	„	52½	„	„
400	„	47½	„	„
500	„	43½	„	„
600	„	42	„	„
700	„	40½	„	„
800	„	39	„	„ bottom.

The surface temperatures have been found to vary from 77½° Fahr. in April to 84½° Fahr. in September.

The counter current running to the westward along the Cuban coast is rarely felt at more than three-quarters of a mile from the shore, and, excepting at the surface, is much colder than the main easterly stream, observations giving a temperature of 69° Fahr. at a depth of 100 fathoms. This westerly current varies in speed from ¼ to 1 mile per hour, and has occasionally been noticed to disappear altogether, the set in these rare and always brief periods being easterly. The main stream itself is subject to the most extraordinary changes, sometimes running at a speed of 4½ miles per hour, and on other occasions scarcely attaining one mile. Sometimes the easterly current is noticed right across the straits up to within a few miles of Sand Cay Light, at other times it seems confined to a comparatively narrow belt on the Habana side.

Up to a distance of between 30 to 40 miles from Sand Cay the currents are very variable, both as regards direction and strength, running sometimes to the N.E. and at others to the N.W. They do not seem to be governed by local causes, such as winds or tides; they frequently disappear altogether.

The character of the bottom along the line already referred to may be briefly described as : round Cay West reefs of coral and rock extending out to Sand Cay; from this point, across to the Cuban shore, sand, a little light-coloured mud and decomposed coral, with the exception of two or three small patches of rock. The Cuban coast descends abruptly and irregularly in pinnacles and ledges of rock and coral. For other features of the bottom in this locality we refer our readers to our issue of August 6th, 1886, page 137.

As we follow the stream in its northerly course the straits become narrower, till at Cape Florida the extreme breadth is only 45 miles, and the greatest depth 370 fathoms. Leaving the straits and going northwards the stream broadens till off Nantucket it is probably 300 miles wide, with a daily speed of from one to two miles, and a depth of 200 fathoms. Want of time and space prevent us from following its course any further, but we believe it can be traced as a body of water at a higher temperature than the surrounding ocean, and constantly moving in one direction for more than 3,500 miles, starting from the Straits of Florida, where it becomes the Gulf Stream proper.

We are chiefly indebted for the foregoing summary of some of the principal features of this most wonderful current to the "North Atlantic Memoirs," and to "The depths of the Sea," by Wyville Thomson, in both of which works the Gulf Stream is discussed at some length. For many of the local details we are indebted to private sources.

ELECTRIC STREET CARS.*

MR. J. MURRAY MITCHELL: Although I only came in at the last part of this meeting, I have been extremely interested and listened with great attention to everything that was said by Mr. Martin, and I only rose for the purpose of corroborating what he has said in relation to the Baltimore road and also to direct your attention, and I think perhaps also his, to the fact that in the comparison shown in his report between horse-power and electricity, the comparison of $6.50 to $4 is not as advantageous to electricity as it should be, because the average speed which is accomplished there with electricity is eight miles an hour, and the speed which they formerly had was only four miles an hour, which of course reduces the cost in comparison, so that the cost of electricity should be put at about $2 as against $6.50, instead of $4, as against $6.50. That, I know, has not been brought out by Mr. Robbins's report directly, but I think it worthy of attention. I should also like to state that, as counsel for the Safety Electric Railway and Power Company, which operates under the Daft patents, I had the pleasure, some two months ago, of closing a contract in Pittsburgh for the equipment there of a railroad to be two and a half miles in length, where the grade is 14 per cent. going up one of those terrible Pittsburgh hills. We first thought of equipping it without any safety device and relying on the mere traction attained by electricity and the weight of the motor; but as there happened to be a curve with a 50-foot radius on the grade of some 700 feet to the mile at that point, and as this happened to be on an elevated structure, something like our elevated roads, and as the danger, if there should be any slip of any kind in going around that curve, would be very great, and would result probably in great loss of life, we thought it better to adopt a system which Mr. Daft himself examined and approved of, using a species of cog rail, but doing away with the old form of cog. It answers the same purpose without having the disadvantages and expense of the old system. That road, I think, will be fully equipped by the latter part of March, and probably be running by that time, or in the early part of the spring. We have, too, there the underground conduit, which is being constructed by Mr. Wharton, of Philadelphia. He took the sub-contract. He is a man who has built a great many of the cable roads. We have a very strong form of conduit, it being formed of slot rails seven inches in height, and they are supported by ties and also by chairs, which are made very heavy, and almost strong enough to hold firmly the slot rails without any other support. This road also has the overhead system, making a combination of the two which has not been previously tried in this country; and I only hope that at the time that road does run I may have the good fortune to see a great many of you out there and have the pleasure of taking you out on the first ride.

MR. J. WETZLER: Mr. Martin has remarked in his paper that one of the principal points to be considered was the coal bill. It is interesting, therefore, to note that in the Julien electric railway at Hamburg a calculation has recently been made on the basis of 1,600 kilometres run; that is equivalent to about 1,000 miles. Mr. Huber, the engineer there, calculates that for the 1,000 miles run the energy required to propel the car one kilometre was, on the average, equal to three-fourths of a horse-power hour. Now, that figures out in this way: If it takes three-quarters of a horse-power an hour to propel a car one kilometre, and assuming that three pounds of coal per horse-power per hour is what a fair, average engine will do, then the energy or coal required to propel the car one mile would be 3½ lbs. of coal per car mile. Now, take for instance, the Third Avenue road in New York. On a basis of 3½ lbs. of coal required to propel a car a mile, we should have, assuming there were 300 cars—I think Mr. Martin puts it at 360—say, then, there are 60 extra cars, which are either summer cars, or cars laid off for repairs, that would give 175 lbs. of coal per car per day. I am basing that figure on a run of 50 miles per car per day. That would give 52,500 lbs. of coal a day, or 26¼ tons. Calculating a ton at three dollars, we should have for the coal bill alone per day only $78.75, and that is with accumulators. I think the company would be very willing to spend $78 for coal, if that will do it. That is what it figures out at.

The CHAIRMAN then called upon M. Julien, who spoke in French, his remarks being translated by Mr. C. O. Mailloux.

M. JULIEN expressed his thanks and his great gratitude for the honour conferred upon him, and wished to say that as Mr. Martin had thoroughly covered the points in his paper, that it was scarcely necessary for him to elaborate them further. He said that the circumstances under which the tests were made at Antwerp were such that they represented almost an inimical feeling to the question of electrical traction by any process whatever. During the six months that the tests lasted every detail of the system was subjected to the closest scrutiny; the cells were sealed, and they were kept almost under lock and key, and he was scarcely allowed himself to look at them. The tests were made by judges, the most competent engineers and electricians, and were made with every precaution that might be necessary to prevent any tampering with the regular order of procedure. There was a feeling which was quite current in the general engineering circles that there was not much reliance to be placed upon electric traction, particularly by accumulators. Even electricians themselves were in such an infantile state of evolution that they thought it might be well enough to wait until they had grown a little further; and as to accumulators it would be well enough not to think of them for some time. Referring to the statement made by Mr. Martin, and the assertion based on it made by Mr. Wetzler, that the expenditure of energy necessary for electrical traction is three-fourths of a horse-power hour per kilometre, and that as the energy required for the lamps must also be counted in, which he certainly thought would be ten cents a day, he calculated that the total expense of about two dollars a day per car would be necessary for the energy actually needed, and that counting an expense of two additional dollars for all other cost of maintenance, wear and tear, interest and various other expenditures, that we would arrive at the cost of four dollars which had been mentioned. M. Julien said that the cost was thus found by the experiments made at Antwerp and that cost might be considered, so to speak, historical; that it might be conceded to be the cost on which they could safely calculate the probable expenditure of running the electrical car with accumulators, on heavy traffic. M. Julien also mentioned his desire to submit his system of electrical traction to the electricians of Paris—to a committee—and to exhibit it there and allow it to be tested in order that the figures and statements as to its value might be corroborated, and the facts as they had been found at Antwerp be known more generally. He stated that there, also, he found a great deal of opposition; that the French electricians had been, systematically almost, preaching against and slandering the accumulator. At any rate, a jury comprising some of the most able electricians was selected. M. Julien's endeavour was to place himself under exactly identical conditions with the system of electrical traction that was exhibited by the firm of Siemens at the electrical exhibition of 1881, and to make a comparison with that on the score of cost, facility of running and various other conditions; and that although the jury comprised men of conservative inclination and disposition like MM. Fontaine, Hospitalier and other men very well known themselves in connec-

* Discussion of paper read before the American Institute of Electrical Engineers, December 7th, 1886. See ELECTRICAL REVIEW for December 24th, 1886.

tion with the application of electric motors, and although M. Fontaine himself took charge of the accumulators and discharged them himself, and did not let M. Julien have anything to do with the manipulation; yet, M. Julien said, he had received a dispatch that very morning stating that they had conceded every point that he had made with them, and that they had found the figures as to cost which he had given them, as being the figures representing the cost at Antwerp, had not even been reached; that the actual estimates of cost of running under the conditions at Paris were much more favourable than those arrived at in Antwerp. He had received two diplomas of honour, one for the car and one for the system of accumulators.

Mr. C. J. VAN DEPOELE: I can simply corroborate what has been said. Still there is one little plant that I might give the exact cost of because the cost is about the main thing to be considered. We ran a plant in Minneapolis, Minn. This is, I believe, the largest electric railroad ever run in this country, or anywhere else, so far as I know. We have there about a sixty horse-power motor, and the train consists very often of ninety tons weight, or ninety-one tons. We have run it for about nine months. I might state also that they have tried a soda motor there, which I will tell about later. But at all events we have been running there at about an expense of three thousand pounds of coal a day—that is, starting to work at six o'clock and running till half-past eleven at night. Certainly, any of the locomotives that used to do the work before consumed as much as four tons of coal a day for the same work, which shows that although we have to transform our power twice, still we will have a great economy over the ordinary steam engine. Our system is not now running for the simple reason that some other parties persuaded the authorities there that they were going to bring there for them to use something wonderful in the shape of a soda motor—a soda fountain with a stick in it, or something of that kind. The soda motors came and we went off the track and let them on. But let me say those soda motors can hardly pull themselves and at present are lying there like a lot of old scrap iron in the shops of the railroad. Of course the authorities there would not at the present time like to take back the electric motors for fear of stultifying themselves. But we ran very practically over that route, using only very common apparatus. The whole thing was only a common freight car with four ordinary thirty-six inch wheels and an ordinary gearing from the motor to the countershaft and from the countershaft to the axle of the wheels and to the axles of the common cars, wearing out only one belt in all that time and working eighteen hours a day, carrying forty-seven of their regular railroad trains a day. So it was shown that electricity can be used for heavy work as well as for light work. Another instance in which figures might be given—of course all this figuring will come much easier after we have big plants running—is this: We are now putting up a big plant in Montgomery, Ala., where we have twelve cars running, and when all is finished we will be able to give the exact cost of running; but so far as we have tried it, and the grades are six and a half and eight per cent. there—in fact, there is not a foot of level ground in Montgomery—with two cars we have consumed an average of nineteen hundred pounds of coal a day, so that it costs but five and a half or six dollars a day with the two cars with the engineer's wages. This is a very small plant, and if small plants can do as well as that, larger plants can do much better.

Mr. C. O. MAILLOUX: Mr. Chairman, I am interested in electric railway matters just as I am in other branches of electrical engineering such as once in a while come under the province of an expert and have to be investigated. At the same time, while I am watching its development, I like to look at things from a practical point of view. There is a question which is now agitating the minds of practical engineers, and which gives me the opportunity to ask Mr. Van Depoele a question. It is this: There is a great deal of doubt, a great deal of difference of opinion, as to the manner in which the energy shall be applied to the shaft of the motive wheel—the driving wheels. I heard Mr. Van Depoele say that he gears his motor to a countershaft and that he conveys the motive power from that countershaft to the driving wheel by means of a link belt. Now that link belt is, I understand some to say, one of the bugbears of the electric railway, and I would like to ask Mr. Van Depoele about the length of time that that link belt has been running; also about how great a velocity it will stand safely. That is to say, how many feet per minute will it run without making too much noise or without being strained unduly; and, also, how long the link belt will last under those conditions?

Mr. VAN DEPOELE: I will be very glad to answer this question. We have some link belts running now for the last eight or nine months on street cars. We have tried several different modes of transmission to gear directly to the axle of the car, something which will obviate the vibrations transmitted by the axles running directly over the road. There at once we have a flexible connection between the motor and the car. The motor can stand on the same body as the car itself and consequently does not participate in the heavy vibration to which it would be subjected if it were carried directly by the axles of the wheels. Consequently, with street cars that is about the best connection I can find at present. I would have it understood, however, that any ordinary link belting in the market will not answer the purpose. We have a link belt which we had made for the purpose of our business. We have tried the cast iron link belt, and found it to make considerable noise, and to wear out too fast, while it is not capable of running at a high speed. I have run at thirty miles an hour, and I did not myself formerly believe that a link belt could do the work, but it seems that when it is solid and correctly made you can run it at the speed without hurting it. The link belt used by us consists of two side pieces of steel pressed, and the steel bushing pieces are then fastened to a steel thimble at the upper end. Right through that steel thimble goes a pin, which catches the two lower ends of the next link, and consequently there is no friction in the small parts, it being confined to the larger surface of the thimble, right over which there is a steel roller. There is really no wear to the chain. We have had in Windsor, Canada, a chain running there for about eight months, and, in fact, it is just as good to-day as when first put down. The belt was then running at about the rate, I should judge, of one-third less than what the wheels were, or fully twenty miles an hour; and at the end of the track I stopped to feel whether the belt was hot, and it was not warm at all. Of course, for heavy work and fast speed, I think the link belt would not be suitable. Then you want to have a direct mode of connecting. Certainly it is very difficult to get a good connection between the motor and the axles of the wheels, because to make a motor large enough to connect directly with the axles of the wheels without any gearing, the motor has to be made too large. I think it would be out of the question to so construct it for ordinary speeds. But to gear back, of course, you have to use some kind of gearing. Friction gear I do not take much stock in. It is not reliable; it wears out, and there is always some trouble about it. Of course the cog-gear is positive, but it makes too much noise. But if you put up gear that is solid and mathematically true and with good lubrication I find there is not much noise when the gear is entirely covered up. We have the same gear in Scranton, which cannot be heard when running. It is well boxed and works well, and does not wear out and fits tightly; although, how long it will last, of course, we do not know. We have several of them running and they run well. If you gear back in the ratio of one to eight you will have a good deal of noise; at one to four you will hardly have any noise at all; at one to eight there will be considerable wear; at one to ten, of course, still more. There is a kind of medium between those and you will have to take your choice in making your proportions; but the link belt, I believe, is the best thing for street cars to-day: that is, a belt made specially for the purpose.

Mr. G. W. MANSFIELD: I certainly would strengthen Mr. Van Depoele's remark that it is a most difficult and an exceedingly troublesome thing to find any good method of connection between the motor and the driving wheels. He has spoken of a variety of methods of doing it, and there are other varieties yet of which he has not spoken. But one thing which he said, viz., that the link belt gave a flexible connection between the motor and the driving shaft, is an excellent plan, and, in fact, it would be necessary where you needed a flexible connection. But I would like to bring up just this one point, and that is, that we have before us two distinct fields to labour in. One field is to equip the 20,000 cars already in this country, running over some three or four thousand miles of track and being drawn by some 125,000 horses, and with the system of construction which now prevails; and the street-railroad men, of all men, I believe, are hunting not only for a means of propelling their cars, but they are also hunting for a better means and better mode of constructing their railroads. Now, with the present variety of construction of a large majority of the street railroads of this country you would need your flexible connection and possible leather belts, perhaps the link belts; or possibly a good combination of gear can be arrived at to get this flexible connection. But the other field is the field of new construction, and this field is the one in which, I think, electricians should specially labour. They should start now, and not wait five or ten years, but should educate the railroad profession and the street railroad men and the street railroad builders—the street car-builders, rather—convincing them that their cars and that the street railroads must be built for electric motors. And if then they are built for the electric motors, we can supply them with something which is perfection, which will entirely do away with a great many evils which exist with horses and with every other means of drawing and propelling the cars, even with the cable. The cable has a limited field; it cannot operate branches successfully, and it has a variety of other evils which I will not speak of now. But with the electric methods in the construction of new roads, due to the marvellous flexibility of electrical application, there is no known or conceivable difficulty that electric motors and the application of electricity cannot successfully eradicate and overcome. So, then, I would merely give expression to this simple, modest thought, which the electric railroad men and the profession engaged in that work should impress upon the minds of all street railroad men, and all men interested in street railroads, viz., that their roads in future must be constructed from the very start for the application of electric motors, no matter by what system, but by the application of electricity. Then, I think, and by that means only, shall we come to the general and successful application of the motors to every railroad throughout the country.

Mr. MAILLOUX: There are two points which I wish to dwell upon in what Mr. Mansfield said. I would begin by the last, although it may not be proper. He speaks of the correct method—the evolutionary method—of the electric railroad as being that in which the electrician anticipates all that now hinders him and warps him in the development of his problem, by beginning from the very first, from the outset, to prepare the road for electricity, all its appurtenances and everything else. That is a conclusion that has already been arrived at in reference to electric lighting. You will find that in the new buildings, the latest large houses, factories, &c., we do not need longer to go to the laborious process of drawing wires through or taking them up to the ceiling; but

we anticipate them by preparing for any system of electric lighting, and put in wires inside of the ceiling instead of having to run them outside. There is here an exact analogy to the remarks of Mr. Mansfield. I was very much pleased to hear Mr. Mansfield speak. I wished that he had permitted himself to go more fully over some of the fine morsels and choice bits with which he could treat us from his stock of experience. He has been intimately engaged in the study of electric railroading for at least four years past, and I do not think that there is anybody here who is better posted in regard to the intricate details and complications of the problem than he; and I have heard him particularly speak of that very question of transmitting power from the motor shaft to the driving shaft, and he made some very pertinent remarks in another meeting before another society on that subject, and I think it would be conducive to the general information of us all if he would briefly review what he said then. I have reference particularly to the methods he spoke of in connection with round belting, &c.

Mr. MANSFIELD: It was at the meeting of the Electrical Section of the American Institute, that I gave an illustration, by means of diagrams, of the different kinds of methods which had been used, as far as I was familiar with them; I can only now repeat, if you desire, just those methods which I presented then, but I do not wish to discuss the efficacy of any single one of them. I said then that the most primal and the most perfect method obviously would be the application of the armature to the driving shaft direct. That does away with every particle of gearing. That method has been utilised by Mr. Daft in regard to a certain system more especially, and that is the Enos elevated system. The motor locomotive has two driving wheels, and the armature shafts extend on each side of the driving wheels, the armatures being keyed directly on the shafts, and, of course, the periphery of the driving wheel is small. It is figured for a certain speed, 12 to 15 miles an hour. The main difficulty which, I think, exists in using this direct gearing is simply a constructional one, on the electrical basis. The ordinary horse car wheel, if I remember rightly, goes only some 10 or 12 revolutions a minute to accomplish the ordinary speed which is used upon the tramways. Now, then, to construct a motor or an armature to go at that slow rate of revolution and develop any power, you would have to go to just the extreme which Mr. Van Depoele mentions and thus construct a *pretty* large motor. If you go into the electrical portion of it, you will see that you have got to get a certain length of wire upon your armature to get counter electromotive force and to do that at such a low rate of speed you have to construct a *rather* large machine, I think. Now, then, there is, next, a simple pinion upon the armature shaft, which runs in a large gear and is keyed upon the driving shaft. That method is simple, but it has its objections, although, if the mechanical details are properly carried out and well proportioned even up to as high a ratio as eight to one or ten to one, I think that a very successful application can be made, and that is the application used on the Baltimore road. Worm gear can be used which is equally as simple as a pinion within a gear; it is equally as simple, but it is not as economical. The action of a worm in a gear is, we have always been told, a very brilliant method of losing power; that as high as 30, 40, 50, and even 60 per cent. of power is lost, due to the friction of the worm within the gear, although Mr. Reckenzaun, I believe, states that he has constructed a worm of a very high pitch and has constructed his gear to match, and he gets a very low loss, 15 or 20 per cent., if I remember rightly, running in oil. Now, then, we go from that more simple process to another one, which is introducing one more subject, and that is, introducing a countershaft. Now we can drive dynamos by a train of gears. We can drive from a pinion upon the armature shafts to a gear upon the countershaft, and then again from a small gear out of that upon a driving axle. Of course, any little difficulties which were apparent in the previous case would be increased in this case by the introduction of another gear. The noise could be cut down by using leather belting, and a variety of leather belts, round, flat, angular, and link belts. An innumerable number of forms of leather belting can be used which would take the rapid revolutions of the armature shaft and carry them to the countershaft with very little loss and with not much noise, and then the slower running countershaft with a pinion upon that, running the slow gear or slow driving axle, can then be employed very easily and with scarcely any noise and with very little wear The flexibility, then, of this system would be between the armature shaft and the countershaft. Now, there can be a different modification of this, even, and I noticed in the *Electrical World* a description of one used by an inventor out West in which he used a train of gears very similar to all the gears that are on the lathe in the ordinary machine shops. That is Professor Henry's method, I believe. Now, that is the perfection of complication, and I do not know that I can go any further than to mention it in just this brief outline of the various ways which I am familiar with, that have been in practical operation. There is one other which I perhaps should mention in regard to a direct running with no intermediate gearing. I ought to have mentioned it first; it is that brought out by Mr. Stephen D. Field lately, and consists in using a crank shaft on the end of an armature shaft which is attached to a connecting rod. That certainly does away with all intermediate gearing, and if he can successfully cut down the speed of the revolutions of his armatures to apply it to a street car, with all the street car difficulties of going so exceedingly slow as to keep pace with a mule that has two tons behind him and a very cross-grained disposition in front, and you have got to go just behind him and cannot go before him—if he can cut it down to that slow rate of speed, of course, for tramways, there could not be anything much better. But for lighter suburban roads, where you have got the right of way, and where you want to run at a rapid rate of speed, of course, then the direct application is superb.

Mr. S. D. FIELD: As to Mr. Mansfield's remarks, there are two ways to obtain the equivalent of speed of armature necessary. One is to confine yourself to the ordinary two-pole machine, using an excessive number of armature turns; the other is to increase the number of poles of the machine. This I have accomplished, and with only two brushes. Then, again, with regard to the conduits for city traffic, I propose, in introducing a street railroad on a line already established, to take out the sleeper bodily and put in its place a hollow cast iron girder, the top of which is capped with a steel rail with a flange carried underneath, giving a slot with a sharp angle to the street surface, so that you cannot get a horse's heel calk into it, but you can have your carrier in there. Mr. Martin said that this was the only way to carry very high potentials. I propose to carry 1,000 volts or more, but at the same time have the minimum strain on the insulators: that is, the insulating medium. To accomplish that I establish a power station at either end of the line, have two conductors insulated, and carry a zinc potential in one conductor and a copper potential in the other. Now, every car on such a line has exactly the same potential wherever it may be. By that means I can carry as high as 1,000 volts on the line with great ease, and you have got to have this high electromotive force with a large number of cars and reasonably sized conductors. There is no other way to do it that I can see. Then for very large motors I wish to call your attention to a little improvement. You know how the things will spark unreasonably. I find that the spark is not governed by anything particularly. It seems to vary with the load, and with the machine, and with the man that works it. I thought I would let the spark govern itself. I have put a couple of brushes on the commutator at points of nominally equal potential on either side and connected them with an auxiliary motor called the brush governor. As long as these brushes are at the proper point no current will pass into them. But let them get ever so little out and immediately the current commences to go through the auxiliary motor, which turns the brush holder to position of neutrality. The result has been very satisfactory.

Mr. J. M. PENDLETON: Mr. Martin in his paper took the occasion of saying that those who spoke well of the accumulator had been looked upon as knaves and fools. As the accumulator and its uses have formed the main subject of my investigations in electricity, I felt that, although I have been thoroughly consistent for the last five years in the matter, we have now arrived at a time when we could boldly face electricians and the public with the service, and the good service, that the accumulator was capable of. It is now some two years since its value in connection with electric traction came to my attention. I have appreciated and understood the remarks of our distinguished guest, M. Julien, to-night, one of the gentlemen whose name was thoroughly familiar to me as the associate of M. Camille A. Faure, and whose intelligent work in the development and the application of the accumulator to railway traction was appreciated by us before his arrival in this country. The remarks made to-night will go far to instruct the railroad men of America in the fact which we have known long since, that the electric motor is the engine best adapted for their purpose.

Mr. MAILLOUX: I would like to suggest to Mr. Pendleton that he might tell us something about his system in connection with accumulators, which he has brought forward and which seem to possess some features of merit, namely, the combined conduit and accumulator system.

Mr. PENDLETON: The system which Mr. Mailloux has referred to is a combination of a conduit with an accumulator system for energising the motor. On nearly all of the systems of electric railways there will be a necessity for distribution of passengers at the different termini, and it occurred to me some time ago to study up the matter, and devise a way of refreshing the accumulator during service and in the direct transmission of energy from the station to the car. There is always the question of insulation and loss by resistance which has formed a very difficult problem, in many instances, to solve, as we know, by the different railways which have been established in Europe. But by combining the two systems we get extra convenience and elasticity. Current is taken directly from the dynamo where it is the most economical, and over the parts of the line where resistance comes severely into play, the accumulator would afford a means of propelling the car, as at the termini.

Mr. PENDLETON then described the system in detail.

Mr. STILES, of the Van Depoele Company, in reply to inquiries, stated that his company was running something like 30 miles of track daily and about 28 cars. "The road that we have been running at Minneapolis is being run by steam cars. The cars were ordinary cars the same as steam cars. We put it in as a temporary affair to enable the company to run their cars until they could get some ordinance to allow them to run by steam. However, they have offered to purchase the apparatus of us but they have had some misfortunes and especially in the soda motor line. They were trying to operate four soda motors made by the Baldwin Locomotive Works. The last time I was there, Mr. Hill, the engineer—there were four boilers built by the gentleman—called my attention to the coal on the floor—about two bushels. He said that was the last of 30 tons they had used to charge that one motor with, and they had not got it to run yet."

INCANDESCENT LAMP PATENTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* Lords Justices COTTON, LINDLEY and LOPES.)

ON Friday, last week, Sir Horace Davey, Q.C., on behalf of the defendants in this action, appealed against the decision of Mr. Justice Butt, delivered on May 25th, 1886, in the action for an infringement of the Cheesbrough patent (No. 4,847 of 1878), which describes an improved method of charging an electric lamp, and the production of a better carbon for use in electric lamps. The whole of Friday and part of Saturday were taken up by the opening address of Sir Horace Davey. He was followed by the Attorney-General on behalf of the plaintiff company, who did not conclude his address until midday on Tuesday. Mr. Moulton followed on the same side, finishing at a corresponding hour on Wednesday. Sir Horace Davey's reply occupied the remainder of that day, and at its conclusion their lordships intimated that they would reserve their judgment.

Sir Horace Davey, Q.C., M.P., Mr. Macrory, and Mr. H. G. Rawson were for the appellants; the respondents were represented by the Attorney-General (Sir Richard Webster, Q.C., M.P., Mr. T. Aston, Q.C., Mr. Fletcher Moulton, Q.C., M.P., and Mr. P. Edward Dove.

Sir HORACE DAVEY said the appeal was against the judgment in the action given at the trial by Mr. Justice Butt, sitting as an extraordinary judge of the Chancery Division on May 25th of last year. Without reading the terms of the judgment it would be sufficient to say that the validity of the patent in question, which was a patent granted to a person, named Cheesbrough, on November 28th, 1878, No. 4,847, was established, and that the defendants had infringed it. An injunction and account were granted in the usual form. That patent was attacked by the defendants on the ground that it was anticipated by certain papers published in this country in the *Chemist*, and they also relied on publications in a paper referred to in the previous case, published by a French gentleman, named Sidot, in the year 1870, the publication of which in this country was admitted. The questions, he thought, would turn to a considerable extent upon the construction to be put upon the patent. According to their contention it was a patent simply for a material and for a process, and neither the material nor the process of making the material was new at the date of the patent, although it was very possible and indeed probable that the gentleman who took out this patent was not aware of what had previously been published in this country. His learned friends on the other hand contended, and the learned judge seemed to have taken that view, that the patent was for the application of a material and the process of making that material to the particular purpose of making the illuminating burners in incandescent electric lamps. The defendants contended before the learned judge that even if that were so, there was no novelty in the application which would sustain the patent. That was the general nature of the questions to which their lordships' attention would be directed. It would be necessary to read the evidence at some length, because they thought, and still thought, that they got everything they wanted from the cross-examination of the plaintiffs' witnesses, and did not put in any oral evidence on their own account. Cheesbrough was, in fact, an importer of the alleged invention on a communication made to him by William Edward Sawyer, of New York, and Albon Man, of Brooklyn, in the United States. The title of the patent was originally "Improvements in and relating to electric lamps, and to a method of charging such lamps with an artificial atmosphere and purifying the same, and to the production of a carbon for use in electric lamps and for other electric purposes." As altered the title of the patent was "Improvements in and relating to electric lamps and to the production of a carbon for use in electric lamps." One of the points in the case was that the plaintiff's witnesses said that the term electric lamps in that title and in the claims was confined exclusively to incandescent lamps. Some of the later witnesses said this, but the earlier witnesses, Dr. Hopkinson, he believed, expressed the opinion that both title and claims extended not only to incandescent lamps, but to arc lamps as well, and something might turn upon that. Having read the specification, interspersing running comments, Sir Horace Davey said he would paraphrase this description shortly by saying that what the patentee proposed to do for the purpose of making his carbon was to fill a vessel with something, he would say at that moment hydro-carbon gas, although he did not confine his claim to that, and a very important question would turn upon that. The patentee supposed himself to have discovered that the effect of passing a current through the carbon conductor immersed in a bath of hydro-carbon gas would be to decompose the gas, whereby a deposit of carbon would be made on the conductor. In the first place, the deposit of carbon would fill up the pores in the conductor, making the latter denser and more homogeneous in its composition. When the pores were filled, the deposition would continue, and the size of the conductor would therefore be increased. The patentee made the remark in the specification that if the current were sufficiently increased there was no practical limit to the amount of carbon which might be deposited, and he further said that to increase the size of the conductor the current must be increased. This was a fact perfectly well known to every scientific person. The amount of heat depended upon the resistance of the carbon, which resistance varied inversely as the sectional area, so that as the sectional area was increased the resistance would be reduced, and a stronger current would be required to maintain the same degree of heat. The only supposed novelty was in the making of the carbon, and he (Sir Horace Davey) submitted that that was not actually new. The first claim was for "the herein described method of preparing the illuminating part of an electric lamp, consisting of electrically heating the same while it is surrounded by a carbon gas or liquid." The second claim was for "The manufacture of the illuminating conductor of electric lamps produced by electrically heating the carbon in a carbon gas." These were the two claims which it was alleged that the defendants had infringed. His contention was that the first claim was for the process which the patentee supposed he had discovered of decomposing a carbon gas, as he called it, by electrically heating, and thereby getting a deposit of carbon on the conductor. The second was for a material, that was to say, for the carbon when produced by the process alluded to in the first claim. The material which he described was of bluish colour, homogeneous and dense. The submission he would make was that exactly the same process had been described by Despretz in *Comptes Rendus* in 1849; the material produced by Despretz's process, it was admitted by plaintiff's witnesses, was identical with that described in Cheesbrough's specification. Sidot in 1870 also described a material which was proved by the evidence to be identical with Cheesbrough's. His learned friends might say that Despretz did not point out that the carbon he produced was useful for electric lighting. His answer would be that what the patentee supposed he had discovered was the process or method of making the carbon. When the carbon was obtained there was no novelty in the application of it. A man could not take out a patent for a particular use of a previously known material, or a material produced by a previously known process, unless there was some novelty in the application, that was to say, unless the application involved invention, ingenuity and thought. There was no such novelty of application here. He could show by the evidence that the application of the material to, at any rate, arc lighting was admittedly well known. There was a contest whether Sidot referred to arc lighting or to incandescent lighting, but whether one or the other it was admitted that Sidot produced a material identical with Cheesbrough's, although he did not produce it in exactly the same way, and pointed out its usefulness for, at any rate, arc lighting. Another point was that the specification was hopelessly bad from vagueness and inaccuracy. Dr. Hopkinson said, to his mind, "The illuminating part of an electric lamp" was equally applicable to an arc lamp and to an incandescent lamp. There was some doubt amongst scientific men whether the light of an arc lamp was given by the spark passing between the two electrodes, or whether it was given by the incandescent tips of the carbons. Probably both were instrumental in the radiation of the light, but there was undoubtedly an illuminating conductor in arc lighting. He should submit that, whether he was right or wrong as to his first point, viz., that the patent was for a method and material previously known, the claim was expressed in such a way that it would cover the use of the material and method in an arc lamp, and that, at any rate, had been published previously. Then his next point was that the specification was insufficient. He claimed surrounding the conductor with a carbon gas or liquid. Chemists told them that there was no such thing as a carbon gas or liquid; carbon gas was not a scientific expression. Dr Tidy supposed the patentee meant a gas or liquid of which carbon was one of the constituents. If that were so there were numerous carbon gases and liquids which Dr. Tidy admitted would not do. He (Sir Horace Davey) believed there was actually no liquid in the world which was not a carbon liquid in the sense that it contained carbon as one of its constituents. A cup of tea even contained carbon. Bees-wax and balsam, substances suggested in the specification, were not even hydro-carbons, which was what it was suggested the patentee meant to indicate by carbon gas or liquid. That being so, he submitted that on the authorities the patent was bad on the ground of insufficiency. There was remarkable proof that the patentee himself did not know what were and what were not suitable things to use, for in one part of his specification, reading between the lines, it was evident that he thought carbonic acid and carbonic oxide would decompose with the result of depositing carbon. Sir Horace Davey then proceeded to cite the alleged previous publications. These were Despretz's paper in *Comptes Rendus* (re-published in the English *Chemist*) in 1849; Sidot's paper in the same publication in 1870; a paper of subsequent date in the *Annale Industrielle* by St. Edmé, embodying the statements of the first two; and a paper by Sir Wm. Grove, published in 1847, in which it was shown that if an electric current were passed through a platinum wire in an atmosphere of hydro-carbon gas the hydro-carbon would be decomposed, and carbon would be deposited. He did not, however, rely upon the last stated publication as an anticipation for the reason that it related to a platinum wire and not to carbon.

The ATTORNEY-GENERAL said if the argument of Sir Horace Davey was to prevail it would be necessary to write the Statute of Monopolies out of the Statute Book, and certainly hundreds of patent cases had been decided altogether wrongly. The way in which the two cases between the present parties, and notably the action now before their lordships, had been conducted was most extraordinary. No evidence in this case was called on behalf of the defendants. Issues which had been over and over again pointed out by the Court to be issues of fact, and issues of fact with which the Court could only deal on evidence, had been treated by counsel as if they were matters of special pleading, and it had been suggested that the specification had to be construed, and that the issues had to be decided, not upon evidence, but upon the

special pleading arguments of counsel, founded upon their own surmises as to what the evidence meant. He (the Attorney-General) would go further, and say that if Sir Horace Davey's argument was correct he must assume and as counsel state to their lordships scientific facts and make scientific assumptions for which there was absolutely no warrant on the face of the evidence. It increased the task of those who had to support patents of this kind immensely if they were to have a completely new departure, if they were to have these issues treated, not by dealing with the evidence given at the trial, but by suggestions to their lordships that the Court had to find out difficulties. He could assure their lordships, on the judgments delivered and acted upon for 20 or 30 years, this practice had never been adopted before, and the Courts had not regarded either specifications or patents from that point of view. To take one instance, it had been decided over and over again that if the specification was proved by evidence to be such that the competent workman could carry it out, that was amply sufficient to support the conditions of the patent. The sufficiency of this specification to enable people to carry out the process had been proved by four gentlemen whose veracity Sir Horace Davey did not dispute. There were sitting in court behind Sir Horace Davey chemists of the greatest experience; on one occasion Sir Horace suggested that an answer given by the witness surprised his chemical witnesses; and yet those witnesses were never called. If his learned friend wished to suggest that the specification was bad because a workman would not understand it, and might be misled into trying carbonic acid and carbonic oxide, it was his duty to call evidence; no suggestion of counsel, however eminent, made evidence that the specification was misleading, when there was evidence that the patentee had explained his invention in a proper manner. This was not the only answer to his learned friend's point as to insufficiency. It was most extraordinary, if those who instructed his learned friend had called his attention to the other part of the specification, that he had not seen that the point was not open to him, for it was pointed out on the face of the specification that carbonic oxide and carbonic acid would not do, and nobody reading the specification could possibly have thought that the hydro-carbon gas or liquid supposed to be employed, could by any possibility include that which was in one sense a hydro-carbon, but not in the sense in which the patentee was using the term. Coming to the question of novelty and subject matter, he would again say that the theory of Sir Horace Davey could only be supported by excluding from consideration all the decisions which directly dealt with the point, and by taking a class of decisions which according to his (the Attorney-General's) submission, were not analogous. What analogy was there in the Brunel fish-plate case? In this case it was not admitted by any of the witnesses that what the plaintiff had done had ever in fact been done before. It was never suggested by counsel at any stage of the case in the court below that the invention of Mr. Cheesbrough consisted in applying the current gradually in the sense that the invention would not work without such a gradual application. It was not a fair construction of Mr. Justice Butt's statement, or of the evidence, to say that such was the view put forward. Mr. Justice Butt was stating what was the effect of carrying out Cheesbrough's description; he was pointing out that if the current were increased all holes in the conductor would be filled up and porosities would be got rid of. It would be a most unfair construction of the specification, and one which could not be supported without flying in the teeth of the whole of the evidence, to say that the essence of the invention was the graduated current, and that there should only be the application of a graduated current, because it was perfectly possible that with certain conductors the graduated current would not be necessary. With regard to the alleged anticipations, he denied that either Despretz's or Sidot's process would get rid of the porosities in the carbon; and it was just because the porosities could not be got rid of, that nobody ever succeeded in making as good a conductor for electric lighting purposes as Mr. Cheesbrough described. There were 75 anticipations alleged of this patent, descriptions of electric lamps with carbon conductors, of vacuum lamps of all kinds, specifications actually dealing with incandescent lighting; but the whole of these had been abandoned, and three publications in foreign journals which were published in England were relied upon, having no reference to electric lighting at all, except that Sidot said that for arc lighting some of his charcoal might be used. Answering a suggestion of Sir Horace Davey, he said he did not agree, although if it were otherwise the fact would not hurt his argument, that Cheesbrough's specification had any reference to arc lighting. Returning to Sidot and Despretz, it was most remarkable that when you came to understand these so-called anticipations, you found that not only did they not show you how to make Cheesbrough, but they sent you in the wrong direction. Sidot told you to proceed in a way that must result in failure, and Despretz told you not to use the things which were most successful, which, in fact, must be used for the purpose of carrying out the process according to Cheesbrough's patent. Nobody prior to Cheesbrough had ever shown how to produce the material in the way in which Cheesbrough ultimately produced it. The outside to which the facts could be stretched by the argument of his learned friends was that a part of the carbon operated upon by Despretz would have some of the properties to a certain degree, of the carbon operated upon by Cheesbrough. What these defendants had done was to take bodily the Cheesbrough patent and improve their lamps enormously. These were not gentlemen who came and said, "By a long process of discovery we have found out how we can get good carbon." But after the Cheesbrough patent had long been known to the world, they said, "We will now, by the light of 1886, pick out three obscure publications, which have nothing to do with electric lighting, and we will construe those so as to describe that which Mr. Cheesbrough made, although nobody has ever produced it, and although one of the most experienced chemists of the day, having read the descriptions of both Despretz and Sidot, and desiring to get at the very thing, has tried it and failed." No court had ever said that, if it was sworn on evidence that the previous scientific description did not describe the invention, no Court had ever said, "We will ourselves come to the conclusion that that previous scientific description does describe the invention." He was not saying that there might not some day be a case in which, on the face of two documents, the terms were so simple that they required no explanation. One could imagine foolish patents being taken out, or things for commercial purposes made the subject of letters patent which were practically identical with what had gone before; but his point was this: given that there was no *de facto* use of the invention, no actual anticipation, and that they had to pick it out from scientific treatises, he would challenge his learned friends to point out a single case wherein it had been suggested that the Court might take that previous scientific description and in the teeth of evidence which said it did not describe the same thing, say it did. Their lordships could not, and had no power so to do, as judges of law and fact, over-rule the finding except upon evidence where the finding was based on evidence. The Court below had believed the witnesses called, and a statement was made by the counsel for the defendants that their witnesses would have said the same thing. He thought he could satisfy their lordships on an authority to which Sir Horace Davey never referred, an authority on the question of sufficiency of previous publication, that what was described in previous scientific publications was a question of fact and not a question of law. However their lordships might be impressed by the marvellous special pleading powers of his learned friend, they were not justified in over-ruling the sworn testimony of the witnesses called. They were not justified in reading Despretz, published nearly 30 years before, with the light given by Cheesbrough's patent; they would be acting most unjustly in doing so, and contrary to any construction of patent law he had ever heard of in the course of a somewhat extended experience. Having quoted the case of Hills and Evans (31 *Law Journal*), the Attorney-General said if they applied the test there described to the so-called anticipations in this case, those anticipations could be utterly demolished. He could show their lordships that the necessary ingredients for the effective working of what Mr. Cheesbrough described were not to be found either in Despretz, in Sidot, in St. Edmé, or in Sir William Grove, or in all four of them put together. What was the use of citing a case to show that taking a known machine and applying that to a particular use was not subject matter for a patent. He (the Attorney-General) had never said it was. From beginning to end of this case there was no evidence that *de facto* a piece of carbon of uniform section, with the porosities filled up, had ever been produced before Cheesbrough. It was sworn that no such carbon had ever been produced prior to November, 1878, the date of Cheesbrough's patent. Prof. Dewar had never seen it and had never heard of it being produced, and he in 1879 was trying to get rid of the porosity in the carbon and knew both Despretz and Sidot; he honestly tried the methods described by those gentlemen and failed. The Attorney-General then proceeded to read the evidence, the specification, and the alleged anticipations, commenting at intervals upon the pertinent passages. Upon the question as to whether the specification described a conductor for an arc or an incandescent lamp, he contended that the carbon conductor of an arc lamp was not an "illuminating conductor" at all, but simply the conductor which conveyed the current to the point of illumination; therefore the suggestion of Sir Horace Davey that the patent included arc lighting could not possibly be sustained. But he (the Attorney-General) would go upon broader ground than that, and say that no one ever before tried to read a claiming clause without going to the body of the specification to see to what it related. Sir Horace Davey had urged Dr. Hopkinson's evidence in favour of his view, but if he had done what Dr. Hopkinson intimated it was necessary to do, if he had read the specification itself and the claims together, he would have had no difficulty in comprehending what was really meant to be described. With regard to the cases cited by Sir Horace, he submitted that not one of them was analogous. First, there was the class of case which related to anticipation. They were every one of them cases in which a known machine, or a known process, producing a known result, was applied in an analogous way, and it was attempted to support the patent for the application of a known machine, combination, or process to produce either the same or an analogous result. These could have no bearing on a case in which the process described was upon the evidence new and where the result described had never been attained before. The next class of case was that which bore upon the question of the sufficiency of the specification, and he would cite authorities to show that from the workman's point of view sufficiency of specification was a question of fact and not of law. In every one of the authorities cited by Sir Horace, evidence was given before the court that the specification could not be carried out. The last class of case his learned friend had brought before their lordships was to the point that the specification was not sufficient on the ground that if properly construed it would include something which had been previously published. He (the Attorney-General)

had never denied that the court had to construe the specification and say what it meant; but he submitted that there was no authority which said a specification was insufficent which properly described the process, and which did not in terms mislead or tell people they could produce what was previously known. It had often been put in this way: You don't tell people who are going to carry out your invention that they may not carry out the old process. You leave people in doubt whether they can work under the pre-existing patent. Nobody alleged that an electric light manufacturer would go to Despretz for the purpose of discovering how to make conductors for electric lamps. The question was, were you on the face of the specification to tell the world that you don't include other scientific experiments; and that you don't cover the result obtained by observers in other researches, when the previous researches had no relation to what the specification dealt with and was not intended either to produce the material or to tell people how to produce it. He submitted that all those cases were inapplicable, unless their lordships came to the conclusion that the patentee when he said material meant an old material and meant to include an old material made in an old way.

Mr. MOULTON said the questions the Court had to decide were, first, did the patentee make the invention? secondly, did he tell the public how to use that invention? and thirdly, did he give the public information sufficient to enable them to make the invention? Had the patentee done his duty to the public? The reason why evidence was of such paramount importance in all these matters was that they called people in to state whether they could draw from the specification the information which it was necessary to have in order to carry out the process, and whether what was described was novel. Once grant that, by accurate or inaccurate, grammatical or ungrammatical language, the patentee had fairly done his duty to the public to whom he was addressing himself, and the Court was obliged to support his claim. Sir Horace Davey made a strong point with reference to the words, "beeswax, balsam, and most oils, if pure, will operate satisfactorily; almost any hydro-carbon, in fact, will answer." Sir Horace objected to the specification because these words appeared. The question, would the competent workman from the specification know how to carry out the invention, was a question of evidence. How had the defendants met that question? The plaintiffs called Sir Frederick Bramwell, who said the specification was amply sufficient to enable the workman to carry out the invention. Then Dr. Hopkinson, who was not only one of the best electricians in England, but was a good chemist as well, was called; and not a single question or answer in his cross-examination would show anything to the contrary. Dr. Tidy, the author of a book on chemistry, said the strict meaning of the word hydro-carbon limited it to things containing only hydrogen and carbon, but the introduction of the words "beeswax, balsam, and most oils," indicated that the patentee did not use the word in the strict chemical sense. Then came Prof. Dewar, to whom not one single question upon this point was put. Nor to Mr. Imray was any question on this point put. At the end of the case Sir Horace Davey said: We, the defendants, are not going to call any witnesses, because our chemists could not carry the matter any further. How could they come now and argue that as a matter of law that was insufficient, when they had not got one single person, on one side or the other, who said there was the least difficulty in applying the specification from the point of view of the workman. Going on to deal with the alleged anticipations, Mr. Moulton said it was remarkable that there was no allegation that the thing had ever been done in England. The experiments of neither Sidot nor Depretz were ever repeated in England before the date of the patent. Therefore it was a question of information conveyed, and not of public use. He submitted that what Despretz described was not the same thing at all as that which was described by Cheesbrough. The heating in the case of Despretz was external, and not by sending a current through the carbon. There was only one evidence of what was understood respecting Despretz's publication before the date of the patent, and that was in an article in a German paper. The impression made upon the mind of the author of that paper was that Despretz did not pass a current through the carbon, but put the carbon into an electric arc. There was no word, either, in Despretz which suggested that his material might be applied to the purposes of electric lighting. With regard to Sidot, his contention was that the material produced was of totally different physical constitution.

Sir HORACE DAVEY said it was a little extraordinary, if his opening argument was of so entirely revolutionary a character as had been represented, that it should have taken four days to answer. Of course his learned friends never wasted time, and he could only assume that, on consideration, they found the argument more important than it appeared at first sight. He was not entitled to the compliments which the Attorney-General and Mr. Moulton had paid him, for, owing to the inadequacy of his powers of expression, he had failed to convey to the minds of his learned friends the points upon which he rested his case. The consequence was that they had, for the greater part of four days, been engaged in the perhaps amusing and exhilarating game of setting up men of straw for the purpose of knocking them down. He and those who were with him may have been wrong in the course they adopted at the trial of relying upon the evidence of the plaintiffs' witnesses, but he could not comprehend why the Attorney-General should complain. His learned friends appeared to him to have entirely disregarded, and even to have contradicted what their own witnesses had said. He conceived it to be the duty of counsel, if their own witnesses could not carry the case further than the statements made by eminent men, who were called on the other side, to say so, and to say, "We accept the statements of your witnesses as to points on which we rely, and we will not therefore trouble the court by proving over and over again what has been proved by your witnesses." Sir Frederick Bramwell said there was nothing in Cheesbrough which was not to be found in Despretz, excepting the direction as to maintaining the temperature. If he had called a dozen witnesses he could not have gone further than that, and he wanted no more than that. Of course that raised the question of law whether that publication of Despretz's paper in England was such an anticipation of the patented process and material as would avoid the patent. That was a perfectly fair argument and one upon which their lordships would give a decision. Dr. Tidy, Prof. Dewar, and Dr. Hopkinson all agreed with Sir Fk. Bramwell, and that being so, he (Sir Horace) had no object in calling witnesses. Prof. Dewar laid more stress upon the graduated current, and he endeavoured to show that Prof. Dewar used the expression, not as relating to the maintenance of the temperature, but to the increase of the temperature, beginning at a comparatively low temperature and going up to an intense heat. He directed his cross-examination to that point, and asked Prof. Dewar to point out that direction in the patent. In the patent they would find the direction to maintain the temperature by increasing the current as the carbon increased in size, which was quite a different thing from what Prof. Dewar said. It might be that he had misunderstood the evidence of Prof. Dewar, and that he was speaking only of the gradual increase of the current. If that were so he went no further than Sir Frederick Bramwell, when he said, "I find nothing further in Cheesbrough than in Despretz, except the direction to increase the current in proportion to the increase in the size of the carbon." If he meant more than that, he (Sir Horace) contended there was no such direction in the patent. With regard to the direction to maintain the temperature by increasing the current as the carbon increased in size and as the resistance tended to decrease, that, he contended, upon the evidence, was not essential to the success of the process, and was only an advantage, the patent being for the process itself and the resultant material and not for advantages. With regard to the material, Sir Frederick Bramwell said there was no difference between the material mentioned in claim 2 and the material described by Despretz. Dr. Tidy said that the material described by Despretz had received the same improvements as Cheesbrough's and had the physical qualities enumerated by him as being the result of Cheesbrough's process. How could any witnesses he might call say more? It was remarkable that when Sir Frederick Bramwell was re-examined he was not re-examined for the purpose of qualifying, modifying or altering that statement in any way, but he was re-examined for the purpose of showing that Despretz's paper contained no mention of electric lighting, and that there was nothing in it which directed the mind of the electric lamp maker to the use of the improved carbon for the purpose of electric lighting, which was not in dispute. If he was wrong in saying that the patent was for a novel process and a novel material, and his learned friends were right in their suggestion that the patent was for a novel application of a material (a known material he said, but his friends did not concede that), so that the prior publication of the process or prior description of the material would not be an anticipation, then he said that the patentee had not described any novel mode of applying the carbons obtained by the process.

LORD JUSTICE LINDLEY asked what the evidence was upon the point which had been raised by counsel as to the manner in which Despretz heated his carbon. It was said that Despretz did not send a current through, but placed the carbon between two charcoal points.

Sir HORACE DAVEY said he heard the suggestion of counsel with the greatest surprise, because the very question was put to the witnesses, whether Despretz made his carbon by passing a current through it, and one and all said he did.

Mr. MOULTON said in justice to his learned friend he must admit that, although upon looking into Despretz it might be seen that he did not do so actually, yet plaintiffs' witnesses took it that he did.

Their lordships reserved judgment.

REVIEWS.

The Ordinary Telephones. (Les Téléphones Usuels.) By CHARLES MOURLON. Second edition, thoroughly revised. J. Lebèque & Co., Paris and Brussels.

This works opens with an introduction in which telephones are divided into two classes. The first class, the musical or "tone telephones," such as those of Reis and Elisha Gray, and the articulating telephones, which alone form the subject of the treatise before us. The invention of this latter class of tele-

phones is ascribed solely to Prof. A. G. Bell, the Reis instrument (October 22nd, 1859) being, indeed, recognised as the "point of departure for all other telephonic systems," but being at the same time regarded as practically incapable of transmitting articulate sounds.

It appears that in France and Belgium Bell's two first patents, those of July 27th, 1877, and of February 13th, 1878, were allowed to lapse on account of non-payment of the year dues, and in those countries everything claimed in the two patents in question has become public property. In Britain and in the United States all the requirements of the patent offices have been fulfilled, and so far the patents have been upheld by the courts.

The successive chapters give full and well-illustrated descriptions of telephones without battery, of carbon transmitters, microphones, of central offices, of the accessories of telephonic installations, conducting wires and cables, insulators, posts and tressels. In view of recent accidents it may be worth noticing what the author puts on record concerning the superiority of silicon-bronze and phosphor-bronze to iron, steel, and copper, as far as aerial lines are concerned. He mentions that in December, 1885, whilst the iron and steel wires at Brussels broke down from the weight of snow clinging to them, the bronze wires resisted perfectly. Again, in October of the same year there occurred a most violent snowstorm. None of the iron lines resisted, but the Stockholm Telephone Company, which employs phosphor-bronze wires alone, to the exclusion of all other materials, had none of their conductors interrupted. In cases, however, where the very posts themselves are torn down, the material used for the wires is unimportant, and only underground lines are safe.

It is impossible to read a work on the telephone without being reminded of that yet unrealised dream of certain physicists, the transmission of visual impressions by electricity. Will, *e.g.*, a manufacturer, sitting in his office, ever be able to see by looking into a camera how different processes are working in various parts of his establishment? Perhaps such result is not feasible. If it should be accomplished it will be by far the most splendid boon which electricity has offered to mankind.

Electricity and its uses. By J. MUNRO. Second Edition, revised and enlarged. London: The Religious Tract Society, 56, Paternoster Row.

The call for a second edition of this work has enabled Mr. Munro to make several additions to the same and on the whole this has been judiciously done, though in some cases the new information given is, we think, rather out of place in a book of the character of a popular work like the one in question; we can hardly conceive, for example, that the description of Muirhead's modification of the Clark standard cell can be of any possible interest to the general reader. We observe also that the book still contains the ridiculous statement that "the Griscom motor is peculiarly powerful, owing to the fact that the currents induced in the coils of the magnet by the rotation of the bobbin with its magnet poles inside it are caused to assist the magnetising current supplied to the ring coils by the commutator, and thus heighten the magnetism of the ring poles." Mr. Munro might be more careful in fresh editions to spell well-known names correctly.

A Pocketbook of Electrical Rules and Tables. By J. MUNRO and A. JAMIESON. Fourth Edition, revised. London: Charles Griffin and Company, 12, Exeter Street, Strand.

The success which this excellent electrical "Molesworth" is attaining is well deserved; as each edition appears the value of the work increases.

NOTES.

Private Lighting.—We understand that Mr. Henry Boddington, of Manchester, has decided to light his new country residence, Pownall Hall, by electricity. The installation has been placed in the hands of Messrs. Dorman and Smith, of Manchester, who are now engaged in wiring the Hall throughout. This installation will be carried out in a very complete manner, preparation being made for about 170 lights.

Electric Lighting in Belgium.—A company has acquired the concession for lighting the town of Contich at the following charges:—

For Installation (Incandescence).

1 to 5	lamps at	20	francs per lamp.
6 „ 25	„	18	„ „
26 „ 50	„	16	„ „
51 „ 100 and over	„	13	„ „

For Supply of Light (Incandescence).

4 centimes	per hour, per lamp of	8 to 10	candles.
7	„ „	16 „ 20	„
12	„ „	40 „ 50	„

Arc Lighting.

40 centimes	per hour, per lamp of	500 to 1,000	candles.
50 to 55	„ „	1,500 „ 2,500	„

Electric Lighting at Penzance.—Now that the ratepayers of Penzance have given an opinion in favour of the electric light, the next question for them will be as to the manner in which they will carry out their desires. It is probable, we hear, that a suggestion will be made to the corporation that they should themselves become an electric light company, and undertake the duty of adequately illuminating the town, which has so long been doomed to semi-darkness. For an outlay of about £4,000 a double plant could be obtained, sufficient to light 60 lamps. Thirty of the lamps could be used for street lighting, and the remainder be let out for shops and public buildings. If such a scheme were adopted, efficiency would certainly be combined with the most rigid economy.

Electric Light in South Africa.—A correspondent writing from the Cape of Good Hope states that the "New Somerset Hospital" there has been fitted with the electric light. When a nurse wishes to enter a ward at night she turns a switch, and immediately the room is as bright as in day. This dispenses with the danger and inconvenience of a dimly-burning candle carried by a careless woman, who drops grease and may ignite the bed clothing. Besides, the medical officers say that for ophthalmic and laryngoscopic surgery it is delightful, and even the most difficult operations can now be performed at night.

Electric Lighting in Bristol. — Messrs. Lawson, Phillips and Billings, of the Marsh Soap Works, have just had their factory fitted with the electric light. The installation consists of a number of incandescent lamps of 16 candle-power, the contractors being the Gülcher Electric Light and Power Company, of Battersea Foundry, London.

Electric Lighting in Vienna.—A warm debate took place in the Vienna Town Council on the 13th inst. on the question of granting a concession to the Imperial Continental Gas Association for a central station to light the Court theatres by electricity, when some very hard words were said of this and other English companies generally. The concession was nevertheless granted for 20 years by a majority of 51 to 15.

The Electric Light in Berwick.—The electric light was introduced for the first time into the borough of Berwick last week.

Lighting at Festive Gatherings.—At the annual *conversazione* of the Bradford Philosophical Society held last week, an interesting collection of electrical working models was exhibited by Mr. Maurice Cohen of that town. In the Microscopic Society's section a novel feature was the use of the electric light for illuminating the microscope stands. The current was supplied from one of the dynamos in use at the Technical College where the *conversazione* was held, and the necessary arrangements for fixing one 20 candle-lamp at each microscope were carried out by the local Woodhouse and Rawson Company. The result was very effective and gave satisfaction both to the exhibitors of the microscopes and the public.

Electric Light at Plymouth.—Last Friday night the streets of Plymouth were crowded with sightseers, anxious to obtain a practical knowledge of the relative merits of electricity and gas. Some fifteen or sixteen tradesmen in the principal thoroughfares of the town had their premises fitted with the electric light, either for external or internal purposes, and in every case the experiment proved a success, no difficulty being experienced in sustaining a pure, brilliant and steady light. Mr. Asher Levy, jeweller, of Union Street, had his light fixed outside his shop, some six or seven feet away from the window, with the result that the precious articles displayed therein sparkled with unusual brilliancy.

Electric Lighting in the Navy.—A preliminary trial of the electric light installation on board H.M.S. *Severn* took place at Chatham on Monday last. Captain Lord Charles Scott, R.N., and several naval officers were on board, and at the special request of the former, the search light was kept running for some considerable time, the beam being directed on to three men wearing different coloured coats, Captain Scott's object being to compare the visibility of the different colours brought under the influence of the electric beam. The officers present pronounced themselves highly satisfied both with the installation as a whole, as well as with the search light experiments. During the latter the hand-feed lamp and projector were manipulated by Mr. R. A. Scott, the electrical engineer under whose directions the installation has been fitted.

Cheap Lighting, Very!—A correspondent writes:—"Plymouth seems to be manufacturing electricity at a very cheap rate. The following appeared in the *Western Daily Mercury* of January 24th:—'The Electric Light at Plymouth.—Now that there is every probability of the electric light being permanently introduced into the borough of Plymouth, the inhabitants may be interested to know something of the cost of the light, which is very small indeed. Mr. T. Martin informs us that he has 171 Brush lights in operation on the Promenade Pier, and that each light is of 1,300 candle-power. There are also 30 incandescent lights. The cost of the whole, including the expense of working the engines and other incidentals, amounts to 2s. 9d. per hour.'"

Isle of Man Steamers.—The New Isle of Man Steam Navigation Company is having its steamers fitted with the electric light. Messrs. Dorman and Smith, of Manchester, have received an order to proceed with the first steamer of the fleet, which will be placed on the station on May 1st next.

The Telephone Exhibition in Belgium.—An International Exhibition of Telephone Appliances has followed the Exhibition of India-rubber lately held in the saloons of the Palais de la Bourse in Brussels. It is under the management of the Belgian Society of Engineers and Manufacturers, and we understand that the principal Belgian and Foreign electricians have contributed essays and papers upon telephony. Meetings of the exhibitors, open to the public, will be held every Friday evening, when papers will be read and discussed. Amongst the most important of the discussions will be that upon the recent experiments carried out by Messrs. Van Rysselberghe and Mourlon who have discovered the practicability of employing circuits, hitherto exclusively devoted to telephony, as telegraph as well as telephone circuits, without in any way interfering with the clear and distinct transmission of sound. The latest inventions, the most recent appliances, will be exhibited, and the Society has appointed a committee of experts to draw up a complete report upon the practical value of the various exhibits.

The Telephone in Scotland.—Exchanges were opened in Galashiels and Selkirk on the 19th inst. by the National Telephone Company. The event was celebrated by a luncheon in Galashiels, presided over by the Provost of that town and the Provost of Selkirk. During the proceedings, Mr. A. R. Bennett, the company's general manager, and Mr. R. C. Bennett, the local manager for the district, gave some statistics of telephonic progress in Scotland, from which it appears that only two towns—Hawick and Dumfries—of 16,000 inhabitants or over, will be without exchanges by the end of January. Some telephonic experiments were made between the two towns at the conclusion of the luncheon, with which the guests were much delighted.

Destruction of Telephonic Plant.—The director of the telephones in Genoa has issued a notice saying that the offices must be closed, the damages caused by the recent snowstorm amounting to more than £80,000.

Newcastle Telegraph Clerks.—A meeting of telegraph clerks was held at Newcastle-on-Tyne on Saturday to consider the position of the Telegraph Service with regard to the Royal Commission. The speakers claimed that the service was of as great advantage to the public as any other public department, and that telegraph clerks should be placed on an equality with other clerical branches of the Civil Service. The Postmaster-General's refusal to furnish statistical information, which was essential in stating their case to the Commission, was strongly condemned.

The Pacific Cable.—The directors of the Canadian Pacific Railway propose to send the *Alert* to Halifax to undergo a refit for the purpose of taking soundings for the Pacific cable from Vancouver to the Sandwich Islands.

The Cable Competition.—According to the figures published in New York, says the *Financial News*, the Western Union cables are doing a decidedly unprofitable business. The Commercial Cable competition has been a sharp thorn in the side of the Western Union Company, which, like most of the Gould enterprises, seems to have come upon bad times.

Madagascar Cable.—The French Chamber has had under consideration, since December 9th last, a proposed act, granting to the Comptors d'Escompte (as representatives of an association) the concession, for 33 years, of a telegraph cable to unite Madagascar, Mayotte, Nossi-Bé, Sainte Marie, and Reunion, with Europe via Mozambique. The act has been handed to the finance committee, which will be shortly called upon to dicuss it. It is stated that another banking firm intends to compete for the same concession.

Electric Lighthouses.—Dr. Hopkinson's account of the electric lighthouses of Macquarie and of Tino, which was read before the Institution of Civil Engineers last month, has just been issued in pamphlet form, with the oral and written discussion to which it gave rise.

Mr. Edison.—A message has been received in England to the effect that Mr. T. A. Edison, the electrician, who was recently reported as being seriously ill, is now out of danger. We trust that this later account is correct.

The Indian and Colonial Exhibition Report.—We notice that some of our contemporaries are labouring under a misapprehension respecting the privacy of the document which comes to a conclusion in this week's issue of the REVIEW. It was marked "private and confidential," certainly; but as the letter which accompanied it seemed to negative this, we took the precaution to at once see a member of the Electric Lighting Committee on the matter, and he explained that the "private and confidential" was a mistake, and that we were at liberty to use the report in any manner we pleased.

The Action against Mr. Volk.—On Friday last, at the Brighton County Court, Judge Martineau gave his decision in the action of Simmons *v.* Volk, by which the plaintiff sought to recover £30, in respect of personal injuries sustained by him through the alleged careless driving of an electric tramcar by one of the defendant's servants. The facts of the case have already been reported in these columns. His Honour said there was a quantity of evidence to show that there had been a good deal of "shieing" along the Madeira Road, and that if accidents did not frequently happen they were at any rate very likely to occur. He had, therefore, come to the conclusion that the electric cars were a nuisance and a danger to the safety of passengers using the road. It was admitted that the railway was not under the authority of an Act of Parliament or of the "Tramways' Act," and he had arrived at the opinion that the defendant was liable for the injuries which the plaintiff had received. He had decided to assess damages at £20, and as the question involved in the action was of general and public interest, he directed the costs to be taxed on the higher scale. Plaintiff's solicitor, Mr. Olding, thereupon applied for an injunction restraining the defendant from running the cars in future, but his Honour declined to enter into the question then, giving leave, however, for the application to be made on another occasion.

The Union Electric Power and Light Company, Limited.—*Money* says: "After the bitter experience the public have already had of electric light companies, we should have thought that they had had enough and to spare of so-called storage batteries, which are nothing better—and the lights produced by them—than toys of the most puerile description. However, it is as well to have a good shot when you shoot at all, so possibly the promoters of this concern thought they might as well call their capital half a million while they were about it as fifty thousand. It is only the addition of a cipher. It is true they only propose to raise £125,000 at present by means of £5 shares, but only think of the amount of domestic illumination which can be accomplished for that insignificant sum. But when we think of the possibilities—not to mention probabilities—involved in half a million's worth of electric lighting, our only wonder is that the promoters of the Union Electric Power and Light Company, Limited, have been so modest. Out of the £125,000 now hoped to be raised, the vendors are only to receive the trifling sum of £70,000, or not quite one half. What they will do with it—if they get it—or what the company will do with the balance, can only be conjectured. The realisation of such a stupendous undertaking must surely lie in the realms of imagination." Our contemporary appears to be labouring under a misapprehension respecting the value of storage batteries. The telephone was called a toy once upon a time.

The Tivoli Waterfalls.—The correspondent of the *Standard*, telegraphing from Berlin on Monday night, says:—"An Italian company, which has been formed for the exploitation of the force of the celebrated waterfalls at Tivoli, has ordered the necessary electric apparatus for the lighting of Rome from the firm of Siemens and Halske, of Berlin. The order for the turbines has been given to Seck Brothers, of Darmstadt."

Torpedo Defence.—Torpedoes to be exploded by electric wires from the shore are being laid along the coast of Algeria and Tunis, and two French ironclads are about to be stationed there.

Glow Lamps in Germany.—The Berlin Edison Company, according to *Industries*, has in its manufacture of glow lamps abandoned the old form of bamboo filament, and employs at present round carbon threads, treating them in the flashing pan, as is done in England. Messrs. Siemens & Halske also make similar lamps under license. The company claims a life of about 1,000 hours with an expenditure of energy of 3·3 to 3·6 watts per standard candle, and lamps are now being turned out at the rate of about 1,000 per day. Very few lamps of other types are seen in the larger Berlin installations.

Dynamo Manufacture in Berlin.—The Berlin Edison Company has hitherto been obliged to buy its dynamo machines from Messrs. Siemens & Halske, but with the first of this month the old agreement expired, and the company is now free to obtain its dynamos from any other maker, or to build them in its own works. The latter policy will be adopted, all the preparations for the manufacture of dynamos having already been made. The company has already experimentally manufactured various types of dynamos, and amongst these one with single horseshoe magnet placed vertically with the yoke in the bed-plate and the armature above, similar in arrangement to the machines made now by Gramme, Kapp, and Siemens. The company has also made arrangements for manufacturing plating machines.

Underground Wires.—There are in this country in daily work 171,000 miles of telegraph wires, of which 19,000 miles are carried underground. In Germany there are about 100,000 miles in all, of which 22,000 miles are underground, many of them being long lines connecting Berlin with important fortresses and cities. In France similar conditions prevail. In this country, on the contrary, the underground systems are concentrated in London and in the largest towns.

The Necessity for Unimpaired Communication.—Upon this subject, the *Standard* says there cannot be any question that attention ought to be given to military and state necessities, and that on these grounds, as well as for commercial objects, the submarine cable and the Metropolis should have protected communications not liable to weather interruptions. As a matter of fact, however, underground communications did formerly exist between London and Dover, Birmingham, Manchester, Liverpool, Leeds, and Carlisle; but these wires were taken up on account of the then difficulty of maintenance and the slow rate of telegraphic working.

The International Cable Company.—The proposed new ocean cable to be laid by the "International Cable Company," is an English scheme, says the *Electrical World* of New York, and the bulk of its shares are in English hands. The friendly relations of the company with Mackay and Bennett give rise to suspicions that there is an ulterior object in connection with the enterprise.

Electric Railroads in America.—The *Electrical World* says that the success of the Van Depoele road at Scranton has been so great that two new companies have been chartered to construct and operate separate lines in that city, and yet another is contemplated.

Imperial Cables.—Mr. J. Henniker Heaton, M.P., writing to the *Manchester Courier* on the subject of the conveyance of mails, says:—"If rapidity of intercourse beyond what steamships can supply is required by the State, let the State encourage the construction of submarine cables, and the reduction of cable rates. I have myself undertaken to construct three first-class submarine cables to Australia—one *viâ* Canada, one *viâ* the Cape of Good Hope, and one *viâ* India—in return for an annual subsidy of £360,000, the amount now lost by subsidising mail packets; and to convey all telegraph messages at the most nominal charge, thus saving six weeks' of time."

Central Station Lighting in Vienna.—At the present moment there are seven distinct stations for the supply of electricity projected for Vienna. These are the following:—1. A central station at Neubad for running 15,000 glow lamps in the shops and dwelling-houses of the inner town; contractor, Herr Fischer. 2. A central station in Blutgasse, close to the St. Stefan's Cathedral, also with 15,000 glow lamps distributed in various newspaper offices, shops, some private houses, and the Government printing offices; contractors, Messrs. Siemens and Halske. 3. A small central station close to the Union Hotel, where accumulators will be used, the number of lights not yet ascertained; contractor, Mr. de Calo. 4. Imperial Continental Gas Association, close to the new Burg Theatre, for 14,000 glow lamps, worked by steam engines and direct driven dynamos in conjunction with a series of accumulators; the light will be used in the two principal theatres, the Opera House, the Emperor's Palace, and the offices of the gas company; contractors, the Gas Company. 5. A small central station in the Paniglgasse, for a number of glow lamps distributed in the neighbourhood; contractors, Messrs. B. Egger & Co. 6. A central station in the suburb Mariahilf, for 12,000 glow lamps, steam power, 1,000 H.P.; there will be twelve dynamos, each giving 480 ampères and 125 volts; contractors, Messrs. Kremenezky, Engländer and Leistler. 7. A central station at the water works in Nussdorf; number of lamps not yet ascertained; here transformers on the Zipernowsky system will be used. The realisation of these various projects is, says *Industries*, to a certain extent retarded by the action of the Municipal Council, which, in its jealousy of allowing the development of anything approaching a monopoly, goes long way towards making improvements of any kind impossible. The conditions to which electric light contractors are asked to submit are very onerous; for instance, the gas company is asked to pay a rental for the right of way for its street mains of 1 kr. (about ·19 of a penny) per annum for every yard of conductor, and for every service lead between mains and houses 1 fl. per annum. In addition, it is asked to hand over to the town 5 per cent. of its gross income from the sale of electricity. It is further proposed that, by giving a year's notice, the town can at any time compel the company to sell it the undertaking.

Sir Charles Bright's Inaugural Address.—The following comes to hand from a correspondent just as we are going to press:—"I am not surprised to find that many besides your correspondent of last week have felt disappointment at the tone of Sir Charles Bright's remarks. With the exception that his address entered with great minuteness into the invaluable services rendered by the author himself, I have failed to find much of novelty or interest, and it appears to me to have left only a very few crumbs of κυδος to be picked up by others whose services had perhaps been quite as great, but who did not happen to be exactly in the same swim."

Electric Lighting at Leamington.—As we have already informed our readers the Corporation of Leamington has entered into an arrangement with Messrs. Chamberlain & Hookham for lighting that town by the electric light. The lighting will, in the first instance, be of a temporary nature, and the work is to be put in hand at once. The Town Council has agreed to take 500 lamps for the Town Hall, Parade, &c., and a number of shopkeepers have already promised to adopt the light. It has been ordered for the Theatre, the Public Hall, the Clarendon Hotel, the Bath Hotel, and the Post Office. The total number of lamps is thus brought up to 2,000, although no general canvas has yet been made. The contractors recommend the use of the incandescent lamps, and it is with these that the Parade will be lighted. The average price will be one farthing per 18 candle-lamp per hour, with a minimum charge of 2s. 6d. per lamp per quarter. The consulting electrical engineer is Dr. John Hopkinson, F.R.S. It is contemplated, in connection with the installation, to introduce electricity as motive power for such purposes as chaff cutting, pumping, hair-brushing by machinery, and driving sewing machines.

A Leamington paper protests against that town being made the arena of a series of experiments for the benefit of Birmingham, or in the interests of Birmingham promoters and Birmingham investors backed by a few local malcontents against the Leamington Priors Gas Company. It says that if benefit is to accrue by the introduction of electricity, few will object to the town being made the advertising medium of the company's wares; but great prudence must be exercised by the local authorities, lest at any future time they are trapped into a step which they cannot retrace.

Effect of Electric Light on Plant Growth.—In a communication to *Science*, Mr. Charles E. Putnam, of Davenport, Ia., writes:—"'The light from an electric lamp tower in Davenport, Ia., falls upon a flower garden about 100 feet away; and during the past summer the owner has observed that lilies which have usually bloomed only in the day have opened in the night, and that morning glories have unclosed their blossoms as soon as the electric light fell on them.' The above item, which originally appeared in the *Democrat* of this city, and has gone the rounds of the press, has a substantial basis of fact. The 'Jenney' system of electric lighting was introduced into this city early this past spring, and across the street from the residence of Mr. Henry W. Kerker is situated one of its towers. This tower is 125 feet high, and contains five arc lights, each of 2,000 candle-power. During the past summer, Mr. Kerker's attention was attracted to the singular effect these lights produced upon some day-lilies blooming in his garden. These flowers closed as night came on, but, as soon as the electric lamps were started up, they re-opened, and while the lights were in operation continued in full bloom. As the street is about 80 feet wide, the lights were distant some 200 feet from the flowers. Other similar observations here are reported, but, as they are less accurately verified, I pass them for the present without special mention."

Robbery by an Electric Light Company's Official.—At the Brighton Quarter Sessions recently Frederick Dowland, formerly secretary to the Brighton Electric Light Company, pleaded guilty before Mr. Gates, Q.C., Recorder, to stealing a cheque for £200, the property of his employers, together with other orders for payment amounting to upwards of £100, and Percy Robert St. Quintin, auctioneer's clerk, was found guilty of being an accessory after the fact to the said larcenies. Dowland, against whom there were previous convictions at Exeter, Leeds, and the Central Criminal Court, was sentenced to five years' penal servitude. St. Quintin was sentenced to six months' hard labour.

Festivities. — The ninth annual dinner of the Plymouth postal and telegraph clerks was largely attended both by members of the staff and visitors. Mr. F. Tremain, responding to the toast of "the telegraph staff," took exception to a remark which had been made to the effect that the Post Office provided the money and the Telegraph Department spent it. The latter was in the habit of paying for extensions out of revenue, and could not be expected to pay dividend while the stock-in-trade was increased by the addition of costly apparatus, by which a large amount of wealth had been accumulated. Mr. Groser, editor of the *Western Morning News*, responding to the toast of "the Press," paid a high compliment to the efficiency of the telegraph staff in Plymouth.

How Dare He!—Miss Younglove: Here is a telegram I want sent at once, please. Operator: Yes, miss. (Proceeds to count the words.) Miss Y.: Stop, sir! How dare you read it? That message is confidential.

The Electro-Harmonic Society.—This society, which is now being formed, is not for the purpose of exploiting any new electrical invention, but has the simple object of bringing electricians and their friends together for social and musical enjoyment. The committee consists of nearly 20 gentlemen, the majority of whom are leaders in electrical science, and the intention of the executive is to place before the members of the society the best available professional talent in the musical world. As the musical season is already somewhat advanced, only four concerts have been arranged for during the half-year ending June 30th, 1887, but if the society receives the support which we anticipate, it will remain a permanency, and should eventually take rank amongst the foremost musical societies of the metropolis. Many excellent clubs exist in the City for the benefit of commercial men, who eagerly avail themselves of the opportunity of listening to good music. Why should not electricians have similar privileges?

A Central Station Wanted.—Mr. G. Pedretti, of Milan, is issuing a circular asking correspondence from any one disposed to start a central station for supplying the electric light in a town in Italy, of 70,000 inhabitants, guaranteeing orders to the extent of 1,000 lamps in a radius of 500 yards.

A New Belting.—A new kind of leather belting has been patented by Messrs. Thomas Fleming, Son & Co., of Halifax, which is specially recommended for high speed. It is called perforated belting, holes being made in the leather at a distance of about an inch from each other, by means of which the air which otherwise forms a cushion between the belt and the pulley is allowed to escape. A belt of this kind is said to run much slacker than any other.

Fatal Accident.—On Monday afternoon a young man named Walter B. Lake, of Dorcester, in the service of the Bristol and South Wales Telephone Company, was affixing a telephone standard on the roof of the National Sanatorium at Bournemouth, when he fell and was killed on the spot.

Causes of Fire.—According to the annual report of Captain Shaw, of the Metropolitan Fire Brigade, among the known causes of fire, spirit lamps now play an important part, considerably more than 200 fires, or quite one-ninth of the total, being traced to this source alone. Gas is less fatal, being accountable for barely two hundred fires, while candles answer for rather more than a hundred. One fire is ascribed to a spark from an electric wire.

Obituary.—Sir Joseph Whitworth, Bart., head of the great engineering and arms manufactory at Openshaw, Manchester, and a famous inventor, expired at Monte Carlo last Saturday night, at the age of 83 years.

Telegraphs and Telephones in the Fire Brigade Service.—Captain Shaw's annual report states that the Metropolitan Fire Brigade employs 28 telegraphs and 39 telephones between fire-stations, 54 alarm circuits round fire-stations, with 347 call-points, 3 telegraphs and 18 telephones to police-stations, and 14 telegraphs, 20 telephones, and 15 direct fire alarms to public and other buildings. The substitution of telephones for telegraphs, which was commenced some years ago, still continues, and though for financial and other reasons carried out only gradually, has proved a great advantage. Captain Shaw anticipates that before the end of 1887 the change will be completed throughout the whole of the system.

Memorial of the late Mr. Fawcett.—The memorial of the late Mr. Henry Fawcett (who was Postmaster-General at the time of his death) in the Baptistery of Westminster Abbey, is to be unveiled by Earl Granville this (Friday) afternoon.

The Dangers of Gas Lighting.—On Wednesday, last week, two servants at the residence of Mr. R. W. Byass, Shortlands, Kent, were seriously injured by an explosion which took place on a lighted candle being taken into a room where an escape of gas had occurred. Great damage was done, the front windows being blown 20 feet away. One of the servants narrowly escaped being burnt to death, as she was enveloped in flames.

Last Sunday an aged couple were found dead in bed at Edinburgh, having been suffocated through an escape of gas.

"Seeking for an escape of gas with light" caused damage to property by explosion in two rooms on the first floor and the passage on the second floor on the premises of Mr. J. Benjamin, tobacconist, Deptford Broadway, on Saturday night. John Benjamin, 24, and John Isaacs, 17, were burned on the face.

The inquest upon the bodies of the five soldiers killed by the explosion at Portsmouth Barracks concluded this week, the jury returning a verdict of "Accidental Death," and adding a rider to the effect that they considered the system now laid down by the Government military authorities for the regulation and supervision of gas was most unsatisfactory, and ought to be altered forthwith.

Secondary Batteries.—In reference to Mr. Barber-Starkey's experiments, Messrs. Drake and Gorham write to us as follows:—"We have read with interest Mr. Barber-Starkey's letter with reference to the use of carbonate of soda in lead secondary batteries to remove sulphate. It is not perhaps generally known that if cells are sulphated as described by him, the positives can be restored much more rapidly if some of the acid is drawn off and replaced by water, thereby reducing the specific gravity. Possibly the action of the carbonate of soda in neutralising the acidity of the solution, produces the same result in another way. The addition of peroxide of hydrogen to the solution will remove sulphate, but we are inclined to think it also damages the plates. We will make up a cell and experiment with carbonate of soda, but should not recommend users of batteries to employ it immediately to any extent, as it may increase the tendency of the oxides to disintegrate and flake off."

New Periodical.—The Old Students of the Finsbury Technical College have resolved upon the publication of a journal in connection with their Association, and the first number is before us, a tastefully-arranged and printed little work, which does infinite credit to the enterprising spirits who are engaged in its production. Its contents are interesting, embracing presidents' addresses, papers read before the Association, and matters of moment in connection with the College.

Underground Telegraph Wires.—At the annual meeting of the Plymouth Chamber of Commerce, Mr. J. Shepheard drew attention to the great inconvenience to which commercial men had, of late, been subjected, owing to the extensive breakdown of telegraphic communication; but it was decided to take no action in reference to the matter, as the question of underground wires was already upon the agenda for the forthcoming meeting of the Associated Chambers.

French Railway Jubilee.—Amongst other jubilees to be celebrated this year is that of the Railways of France. In connection with the commemoration there is to be held at Paris an international exhibition illustrative of the history and remarkable progress of the railway system, which will also afford opportunities for the meeting of congresses of engineers and others interested in railways to discuss matters affecting the future development of the system. Group VI. of the classification of exhibits is as follows:—"Application of electricity to railways.—Class I. The generation of electricity.—Batteries—Dynamos—Accumulators—Magnets—Electro-motor machines—Transmission of Electric power to a distance—Secondary batteries. Class II. Electric signals.—Lighting.—Sight signalling—Sound signalling—Lighting of terminal and other stations—Lighting the track—Lighting of the engines and trains—Electric clocks—Telegraphs—Telephones—Microphones. Class III. Electrical traction for railways.—Electric locomotives—Electric brakes—Utilisation in accumulators of the electricity destroyed by application to the brakes. Class IV. Application of electricity to tramways.—Various systems of electrical machines—Lighting, brakes, and other applications to tramways." The office of the Commissioner for England and Colonies is at New Broad Street House, London, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Latimer Clark, Muirhead & Co., Limited.—The annual return of this company, made up to the 11th inst., was filed on the 18th inst. The nominal capital is £100,000 in £10 shares; 4,709 shares are taken up, and the full amount has been called thereupon. The full amount is considered as paid on 4,702 shares, and £70 remains unpaid.

Woodhouse and Rawson Electric Manufacturing Company, Limited.—At a special general meeting of this company, held at 11, Queen Victoria Street, on the 16th ult., it was resolved, "That Article 61 of the Articles of Association of the company be amended by the insertion of the word 'seven' in lieu of the word 'five' in the second and last lines thereof respectively." The resolution was confirmed on the 4th inst. and registered 20th inst.

Stanhope Company, Limited (formerly Cordner, Allen and Co., Limited).—At extraordinary general meetings of this company, held at the offices, 20, Bucklersbury, on the 2nd November and the 18th November, 1886, the following special resolutions were passed and confirmed:—"No director shall vacate his office by reason of his being a shareholder or director in any incorporated company which has entered into contract with, or done work for, the company of which he is a director." "A director (without being accountable for profits) may make contracts with the company upon such terms as the directors think fit, and may, with the sanction of the directors, engage in any transaction (within the company's objects) in partnership, or otherwise, in conjunction with the company upon such terms as may be agreed upon by the parties to such transactions, but he shall not vote in respect of such matters, and the short particulars of any such contract or transaction, showing the nature of his interest, must be forthwith recorded in the minute book of the directors." The resolutions have been duly registered.

Electrical Navigation Company, Limited. — The registered office of this company is now situate at 12, Queen Street, Cheapside.

CITY NOTES, REPORTS, MEETINGS, &c.

Eastern Telegraph Company, Limited.

THE twenty-ninth half-yearly meeting of the shareholders of this company was held at Winchester House, Old Broad Street, on Thursday, the 20th inst., under the presidency of Mr. John Pender, chairman of the company.

Mr. George Draper, the secretary, having read the notice convening the meeting,

The Chairman, in moving the adoption of the report, stated that the revenue for the six months ending September 30th, 1886, amounted to £292,229, against £331,419, or a decrease of £39,190. This reduction was divided as follows:—Indian and trans-Indian messages, £9,000; Egyptian, £23,000; Portuguese, Spanish, Turkish, &c., £9,140; less one-half per cent. extra dividend for the half-year on the Eastern and South African shares, amounting to £1,950. With reference to the decrease of Indian business, about £4,000 might be put down to the reduction of the tariff in July last from 4s. 7d. to 4s. per word. The falling off in Egyptian traffic was caused by the general quieting down of that country; there being no news of importance, the London papers had almost ceased to send special messages, and Government messages were not so frequent as they were last year. At the same time he was glad to say that there was a slight increase in the commercial business with Egypt, which augured well for the future if peace were maintained and a stable Government established in that country. Of the falling off in other traffic, £7,000 might be put down to the very large reductions they were forced to make at the Berlin Conference in 1885. The reduced tariff came into operation on July 1st, so that they might be said to have been working for something like three months under it. The total working expenses during the six months amounted to £81,025 against £86,935 in the corresponding period of 1885, being a decrease of £5,910. The general expenses in London were £7,964 against £7,905; rent and taxes had increased £340, and repairs, furniture, &c., £360; on the other hand, salaries, wages, office expenses, stationery, printing, and law charges showed a decrease amounting in the aggregate to £681. Working expenses at stations amounted to £58,000 against £60,000 last year. Most of the items under this head showed a considerable decrease, so that the net reduction of station expenses as compared with 1885 was £2,368. Expenses attending repairs and renewals of cables, £53,965 against £45,288, an increase of £8,677. The repairs had been exceptionally heavy this half-year, more especially on the direct Lisbon line, where the *Electra* had to let in 191 miles of new cable. This, with the portions renewed in previous years, completed the renewal of three-fourths of that line, so that they had practically renewed the line out of revenue. Other important repairs had been effected by their ships, particularly one which was broken by an earthquake, necessitating 114 miles of new cable to re-establish it. After paying all charges, including income tax, and providing for interest on debenture stock and preference shares, they were, he was glad to say, able to maintain the dividend of 5 per cent. per annum, carrying forward to next year's account £31,090 against £32,000 in the corresponding period of last year. Judging from present traffic, they might at least hope to carry a fair amount to reserve at the end of the financial year. These were the hard facts connected with the working of the system during the six months. He would continue his remarks and give them a little more information, which information, he believed, would be rather of a cheerful nature than otherwise. He had received several letters, the majority of them from ladies, speaking of disappointment at not receiving any bonus for the half-year, and asking if there was not some mistake. He sympathised with the writers of those letters. The question of the bonus was one of delay rather than of loss. They were aware that when they first agreed to deal with the question of bonuses, it was decided that it should always be kept apart from the dividend—that they should endeavour to maintain a 5 per cent. dividend, and that the bonus should be a fluctuating item. After having received it for some time the shareholders naturally began to think that no change could possibly take place that ought to take it away. But at the Berlin Conference they were forced to agree to tariffs which had reduced their income by £50,000 a year, and that £50,000 was just the loss of the bonus. He had told them on many occasions that any reduction of tariff was a source of present loss to the company. It required time to recoup that loss, and he had no fear that it would be recouped, possibly in a shorter space of time than most of them supposed. In the first three months they were realising the present loss; but since the termination of the last financial year they had found a very considerable improvement in their traffic, and until he met them six months hence he was not prepared to say whether they would have their bonus or not. If they continued to go on as successfully as they had been doing the last month or two they would be doing two good things: they would be reducing the tariff and benefitting the telegraphing

public without reducing in any way the return to the shareholders. The improvement in trade had doubtless been observed by many gentlemen present. He had often said—and he would repeat it, for a good story was nothing the worse for being twice told—that the submarine telegraph system was about the best barometer of trade it was possible to have. The barometer was rising; their traffic was increasing. Consequently, he supposed that the improvement in trade was pretty general. He had shown them that their loss in the Egyptian traffic alone last half-year was something like £23,000. That was a very large sum. They might not be able to recoup the whole of that, because a great deal of the larger traffic sprung out of exceptional circumstances; but if trade improved, as they might fairly expect it would, he thought a considerable proportion of it might be recovered. There was another matter which was practically beyond their control, and that was the heavy expense of repairs; but there was a certain comfort even in that. If they knew that they could repair their cables it was a great satisfaction; and they had the knowledge now from long experience that they could repair them, and by so doing prolong their life to an extent beyond what they had originally calculated. When he told them that one of their ships was employed day by day during five months in maintaining the cable between Lisbon and England, they would see that, while there were great difficulties in repairing, there were generally satisfactory results. Looking to the future, and to the duty which devolved upon them to be ahead of everything that might happen, he might shadow forth something of the line of policy they intended to pursue. Rumous of war were abroad on the continent, and it behoved them to be prepared, should war break out, to be entirely independent of their land system through France; they must rely entirely upon their marine system: they must therefore at no distant date make themselves thoroughly independent in their system between Land's End and Gibraltar and Malta. He had no proposition to make that day, but in times past they generally had had their ships and cables ready when required, and it was the intention of the board to be similarly prepared in the future, should any great Continental war occur. They had another string to their bow should anything happen. They had secured a very large, he might say a controlling, interest in the Direct Spanish cable. Arrangements had been made lately, through the good sense, energy and perseverance of their managing director, Sir James Anderson, whereby such a decision had been given by the Court as converted their large interest in the Direct Spanish Company into a living thing. It had been dead in the sense of its never having been a success, and according to the law of the land where there was a large debt no dividends could be paid. The capital had been reduced, and upon that reduced capital they would get a dividend. It was a living thing in another respect. Should war break out the chances were that they would be able to connect the Direct Spanish cable with their system in the Mediterranean, and thereby get an alternative line should the lines through France become inoperative. All their cables at that moment were in good working order. That was a source of great satisfaction. They were about to lay a short cable from Gibraltar to Tangiers. That was taking possession of another important link in the chain of telegraphy, which was likely to be extended along the west coast of Africa. Within the next few months there was to be a conference in London of all our colonial possessions. A large amount of their traffic came from their connection with the Eastern Extension Company, which now carried the telegraph system to the colonies, India and China. The question of cheaper telegraphs, or the mode of cheapening telegraphs, would be discussed at that conference. They had prepared a scheme, he believed a sound scheme and the only practical one, to reduce the price of telegraphs to those very distant places. Ten thousand miles of cable cost a large amount of money, and a large traffic would be required to make a low tariff possible. They would submit a scheme which they hoped would reduce the rates by something like one quarter of the present amounts, leaving in the hands of the Government the power to regulate those rates and securing for the shareholders a permanent guaranteed dividend. If they could carry out their proposed scheme they would place submarine telegraphy in the place which it ought to occupy, for it was so far one of the greatest and most important contributions which science had given to civilisation during her Majesty's long reign of 50 years. If they succeeded they would have done a good work, and all those who had been connected with submarine telegraphy might feel proud that they had been associated with a system which had been so entirely beneficial. The Chairman then moved the adoption of the report and accounts to September 30th, 1886.

The Marquis of Tweeddale seconded the motion, which was unanimously agreed to.

The Chairman next moved the re-election of Mr. George Gordon Nichol and Mr. John Denison Pender as directors, which was likewise agreed to, the auditors, Mr. Henry Dever and Messrs. Quilter, Ball & Co., being afterwards re-appointed.

Mr. Hurst moved a vote of thanks to the Chairman, which was heartily accorded and suitably acknowledged, the meeting thereupon terminating.

Direct United States Cable Company, Limited.

THE nineteenth half-yearly general meeting of this company was held on Friday last week at Winchester House, Old Broad Street, under the presidency of Mr. John Pender.

Mr. Fuller, the secretary, having read the notice convening the meeting,

The Chairman stated that the revenue for the half-year ended the 31st ult., after deducting out-payments, had been £19,603, and the net profit had been £3,249, which was increased by the amount brought forward to £6,300. Out of that sum an interim dividend of 2s. a share had been declared for the quarter ended September 30th last, leaving a balance on the revenue account of £229. A further interim dividend of 2s. a share was proposed to be paid for the quarter ended the 31st ult. That would require, in addition to the revenue balance, an amount of £5,842, which would be principally paid out of the interest on the reserve fund investments. They desired to make the effects of the fight in which they were now engaged felt as little as possible by the shareholders, and therefore they had declared the small dividend mentioned. The revenue at the 6d. rate showed a falling-off of £18,512, or about 49 per cent., as compared with the corresponding period of 1885, when the tariff was 1s. 8d., but the actual traffic in words carried by the associated companies had increased by 133 per cent. The rate charged by the Commercial Company was 1s., and he was very much disposed to attribute the large increase of traffic carried by the associated companies to a considerable decrease in the returns of the Commercial Company. The reserve fund of the Direct Company, after being credited with interest on the investments, and debited with £2,479, the cost of the last repairs, now stood at £328,183, and the market value of the investments was considerably higher than their cost price. For the last two years they had been talking of the competition which was now going on, and there were shareholders present who had always urged the directors to meet the competition firmly, in the only way in which it ought to be met. The Commercial Company had come upon them when the Direct Company was paying a dividend of only 5 per cent. and carrying forward a comparatively modest sum; and by reducing the tariff from 2s. to 1s. 8d. the new company took away even more than its proportion of the traffic, which had only sufficed to give the results he had mentioned. The amount of traffic taken by the new company was about £170,000, which gave that company no benefit, while at the same time doing serious damage to this company. At length they had found themselves, by the action of the new company, getting into a worse position every day, and they saw that the only alternative for them was to adopt such a rate as would be most disadvantageous to their competitor, while it was a non-paying rate for themselves. In adopting such a rate they had been influenced by the thought that they would probably induce the other parties to come to an understanding. Before they reduced the tariff to 6d. they endeavoured very hard to arrive at an understanding, but the negotiations resulted in nothing practical. In his opinion there was no use in increasing the 6d. rate until they could go to a point which would give them a fair dividend, and at the same time maintain their reserve fund. That was the position they were in that day, and which the directors asked the shareholders to support them in carrying through. When they began the competition he stated that it might possibly last a year, and it had already been going on for eight months. Some years ago, at the time of the formation of the French Company, some of his colleagues and himself went to Paris and told the promotors that within two years the money they were spending would not be worth a third, and at the present time the market value was not equal to one-fourth of the original outlay. In the face of that result, the same parties who had promoted the French Company had induced Mr. Mackay to go into the enterprise. That gentleman must now be better acquainted with the actual results of his venture, and he was sure that Mr. Mackay was too good a man of business to continue the fight to a disastrous end. He (the chairman) had referred to the French Company, and that company had formed part of the "pool" during what he might call the fairly good times of the associated companies. The French Company, however, which had now changed hands, had intimated its intention of retiring from the agreement. It had no right to do so, but if it did it ought in honour to return what it had received from the "pool" in excess of what it had earned. He could not understand the attractions which the Atlantic offered, but, in face of the results of the working of the existing cable companies, another company had recently appealed to the public for capital to be embarked in the same field. If, however, he was correctly informed, the public had not responded. He concluded by moving the adoption of the report.

Mr. William Ford seconded the motion.

Mr. Guesden said now they were committed to this competition, although he disapproved of it on commercial and moral grounds when it was undertaken, he should not advocate shrinking from it. It must, like all wars, be carried on to the bitter end. But when the chairman told them he tried to come to terms with their competitors he failed to tell them what terms he proposed, which was a very important matter. They had heard frequent disquisitions from the chairman as to the injudicious application of Mr. Mackay's money, a matter which was no part of their business. As a dispassionate man he thought that was stepping out of their way to give Mr. Mackay gratuitous information, an interference with that gentleman's affairs which was quite uncalled for.

The Chairman said no one had ever heard him say a single unkind word respecting Mr. Mackay.

Mr. Guesden, continuing, said it must not be forgotten that in this cable enterprise there had been a great deal to provoke public hostility It had been very arbitrary in many of its transactions. What he wished to know was whether it was proposed to

the Commercial Company to reduce the price per word below 1s. 8d. or to raise it above that amount. If Mr. Mackay had committed himself to a fixed tariff and it was proposed to him to go above that tariff, he could not conceive a greater insult to his integrity than to ask him so to stultify himself. The profit of 5 per cent. which this company had paid was to his mind a very satisfactory profit to any man. But the board wanted to get a good profit on the ledger value, which was a very different thing from the intrinsic value of the shares. They had entered into a combination, and very rightly so, for apart from that combination they would be a helpless, miserable company. No single cable could possibly live alone. They were so closely affiliated to the Anglo-American Company that they were practically part of that company. The combined capital of the pooled companies amounted to something like £10,000,000; but was that capital worth 10s. in the pound? They had to treat this matter just as a man bought a bale of goods, and had to take into calculation the lowering of values. This company had sustained more accidents than any cable enterprise he had ever heard of, but the losses were liquidated and a new company was formed; but that new company could not exist by itself. The best friends of a single cable company could not support it. After referring to increases in the accounts, Mr. Guesden said he was sorry to find capital being raised in his native city, not to promote free-trade, but to prevent it, that capital being employed to handicap telegraphic communication between the two great English-speaking nations to the injury of trade. He then proceeded to condemn the use of proxies and the acceptance of large fees by the directors notwithstanding the losses which the company was sustaining in consequence of competition. The chairman, he remarked, was a director of 15 companies, of 10 of which he was chairman, and it was impossible that he could give proper attention to the affairs of all those companies.

The Chairman: Fortunately they are all successful.

Mr. Guesden said he was quite willing to award to the Chairman all the praise to which he was entitled, but he contended that there were too many directors, and that they were too highly paid.

Mr. Jackson admitted that the talent of the Chairman in telegraphic matters was supreme, but said the fact that the company was a partnership affair was too much ignored. The directors should suffer with the other shareholders. He condemned, however, any attack upon them upon the grounds of indifference to the interests of the shareholders in the conduct of the war that was proceeding. That war was entered upon with the consent of the shareholders, and the directors should have the support of the shareholders while it was in progress. He was disappointed, however, that after eight months no definition of policy had been given to encourage and hearten the shareholders in the fight.

Mr. Newton expressed his satisfaction that a dividend had been paid out of the reserve fund. The misfortune of the cable companies was, that the Anglo-American Company could not do the same. If it could, victory would be in their hands.

The Chairman, replying to the questions raised, declined, in the interests of the shareholders, to state the nature of the negotiations with the Commercial Cable Company before the tariff was reduced. As to his being connected with 15 companies, they were mostly telegraph companies and extensions of one system which it had been necessary to establish in sections. The progress of submarine telegraphy was mainly owing to the fact that there had been so few heads to direct it, and the jealousies of different boards had thus been avoided. As to when the competition was to end, unless the shareholders shrunk from the position they had taken up, the directors intended to firmly continue the policy they had adopted.

The motion was then put and carried.

A vote of thanks was accorded the directors, after which the meeting terminated.

The New Telephone Company, Limited.

AN extraordinary general meeting was held on Saturday last at the offices of the company, 4, Great Winchester Street, E.C., Lord Thurlow presiding.

The Chairman stated that the meeting was convened to pass resolutions authorising the directors to proceed at once with the formation of various district and provincial sub-companies. The moment was most propitious for what they had in view. He thought it was not too much to say that the existing telephone arrangements of London were a disgrace to the country, especially when compared with foreign countries such as the United States, Germany, or even a small country like Sweden. He could mention one town in South America with nearly as many subscribers as there were in London, where, indeed, the telephone had not yet reached the public. The time would come when healthy competition would bring the telephone into every shop and office in London. Various schemes had received their consideration—the issue of further share capital, the establishment of branch companies, and the reconstruction of the old company. This last was the course they had eventually decided to follow. Their company as it stood was only a syndicate. They proposed, therefore, to form a strong company with a suitable capital to take over the assets and liabilities of the old company. They could establish exchanges at a rental of £10 and realise handsome profits. They would not be overweighted with dead capital, as they had paid nothing for their patents, and they would not have to begin by renewing an obsolete and inefficient plant, but would at once step into the latest scientific and mechanical improvements. He would reserve details for the confirmatory general meeting which would have to be held, and which would be called with the least possible delay, but he desired to mention that they were in communication and negotiation with strong representative people in Glasgow, Dundee, Edinburgh, Kirkcaldy, Liverpool, Manchester, Preston, Bristol, Cardiff, Leamington, Birmingham, Bedford, Oxford, Cambridge, Somerset, and very many more places. There was one branch of the business entirely neglected at present which they would largely take up—the inter-communication of towns with one another. He concluded by moving the formal resolution of which notice had been given.

Sir James M'Garel-Hogg seconded the resolution which, after questions by Colonel Steuart, Colonel de Cetto, and other shareholders had been answered by the Chairman, was passed unanimously.

The Cuba Submarine Telegraph Company, Limited.

THE report of the directors for the half-year ending December 31st, 1886, states that the gross receipts (including the balance brought from last account) amount to £17,845 10s. and the gross expenditure (including the half of the annual payment on account of the 1881 cable, and the amount expended on cable repairs) to £6,098 15s. 6d., leaving a sum of £11,746 14s. 6d. to the credit of revenue account. Of this the sum of £1,795 15s. 3d. has been added to the reserve fund, increasing that fund to £66,500.

The dividend on the preference shares will absorb £3,000, and leave £6,950 19s. 3d., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income-tax, the balance, £550 19s. 3d., being carried forward to the current half-year's account.

The cables have continued in good working order, excepting one of the Santiago Harbour lengths, which has been repaired by Mr. Keith, the company's engineer.

The India Rubber, Gutta Percha, and Telegraph Works Company, Limited.—Subject to audit, this company's accounts to December 31st last show the following result:—Brought forward from 1885, £40,947; net profit for 1886, £59,400; total, £100,347. Less interim dividend paid in July, 1886, 5 per cent., £20,800; total, £79,547. The directors have resolved to recommend a dividend of 10 per cent. (making 15 per cent. for 1886), and to carry forward £37,947.

Anglo American Telegraph Company, Limited.—The board has resolved that the balance of the revenue account for the quarter ending December 31st, amounting to £18,847 3s. 2d., be placed to the credit of the renewal fund. The register of transfers will be closed from 21st January to the 4th February, both days inclusive.

The Globe Telegraph and Trust Company Limited.—The directors have declared an interim dividend of 3s. per share on the preference shares, less income tax, and of 6d. per share on the ordinary shares (income tax having already been deducted) for the quarter ending the 18th of January.

The Western Counties and South Wales Telephone Company, Limited.—The directors have issued dividend warrants for the balance of dividend for 1886, at 6 per cent. per annum, payable on February 1st next. An interim dividend of 3 per cent. for the half-year ending June 30th was declared in July last.

Eastern Extension, Australasia and China Telegraph Company, Limited.—The interest due on February 1st on the 6 per cent. debentures will be paid at the Consolidated Bank, 52, Threadneedle Street, E.C. Coupons must be left three clear days for examination.

Eastern Telegraph Company, Limited.—This Company notifies that the coupons on its 5 per cent. debentures, due on February 1st, will be paid on and after that date at the banking house of Messrs. Glyn, Mills, Currie & Co., 67, Lombard Street, E.C.

Western and Brazilian Telegraph Company, Limited.—The directors have recommended a dividend, tax free, of 13s. per share for the 15 months ending December 31st, 1886, being at the rate of £3 9s. 4d. per cent. per annum.

Brazilian Submarine Telegraph Company, Limited.—The coupons on this Company's 5 per cent. debentures, due on the 31st inst., will be paid at the Alliance Bank, Limited. Coupons must be left three clear days for examination.

Western Union Telegraph Company, Limited.—Messrs. Morton, Rose & Co. notify the numbers of the bonds of the 6 per cent sterling loan drawn for payment on March 1st.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 21st were £3,243 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts of this company for the week ending January 21st amounted to £3,963.

NEW PATENTS—1887.

510. "Single-needle telegraphic instruments." J. E. SPAGNOLETTI, J. CROOKES. Dated January 12.

511. "Insular for wires for electrical and other purposes." J. E. SPAGNOLETTI, J. CROOKES. Dated January 12.

551. "Protecting telegraph wires from injury from snow-storms." H. J. NEWCOME. Dated January 13.

563. "Dynamo-electric machine." H. H. LEIGH. (Communicated by J. L. Clerc.) Dated January 13.

564. "Electric motor." H. H. LEIGH. (Communicated by J. L. Clerc.) Dated January 13.

565. "Electric transformator." H. H. LEIGH. (Communicated by J. L. Clerc.) Dated January 13.

571. "Switch for telegraphic transmitting keys." R. M. CUNNINGHAM. (Communicated by T. H. Davis and C. Peeling.) Dated January 13.

629. "Effecting the electro-chemical generation of chlorine in metallurgical operations for the extraction of gold, &c., from their ores." D. G. FITZGERALD. Dated January 14.

634. "Electricity meters." J. HOPKINSON. Dated January 15.

648. "Duplex telephony." A. R. BENNETT. Dated January 15.

700. "Electric furnaces and apparatus for heating, lighting, and carrying on chemical processes; working same." S. Z. DE FERRANTI. Dated January 15.

701. "Electrical meters." S. Z. DE FERRANTI. Dated January 15.

702. "Dynamo-electrical machines." S. Z. DE FERRANTI. Dated January 15.

717. "Disc dynamo-electric machines and motors." W. B. SAYERS. Dated January 17.

747. "Applying electricity to propel vehicles on roads, with or without tram or other rails." F. WYNNE. Dated January 17.

800. "Electric telegraph apparatus suitable for use to communicate between the bridge and the engine room of a steamship and applicable also to other uses." J. B. WILLIS. Dated January 18.

831. "Apparatus for converting alternating currents into continuous ones." M IMMISCH. Dated January 19.

881. "Insulating the electrodes in electric batteries and forming the terminals thereof." F. H. JUDSON. Dated January 20.

886. "Electric heat detecting alarm." J. ADAIR. Dated January 20. (*Complete.*)

893. "Electrical billiard marking repeater and indicator." G. W. HOOK. Dated January 20. (*Complete.*)

897. "Combined electrical operating chair, footboard and metallic brush." G. PESCOD. Dated January 20.

924. Electric lighting and lamps for the same." S. Z. DE FERRANTI. Dated January 20.

925. "Inducing or magnetising parts of dynamo-electric machines, &c." J. WODICKA. Dated January 20.

949. "Electrical switch or circuit closing and interrupting device." G. PERCIVAL. Dated Januarry 21.

950. "Measuring and recording electric currents." T. PARKER. Dated January 21.

990. "Feeding electric batteries and removing the plates therefrom." S. W. MAQUAY. Dated January 21.

1047. "Acoustic or mechanical telephones." C. AUTY. Dated January 24.

1100. "Applying electricity for curative purposes." C. E. LEWIS. Dated January 24.

1155. "Primary batteries." W. A. PHILLIPS. Dated January 25.

1156. "Insulators for supporting electrical conductors." W. D. INGALL. Dated January 25.

1167. "Gas burners in which the gas is ignited by electricity." A. J. BOULT. (Communicated by A. T. Smith.) Dated January 25.

1176. "Musical instruments or chiming apparatus, the hammers of which are operated by electricity." J. HARRINGTON. Dated January 25.

1195. "Switchboards." S. PITT. (Communicated by D. Dewar.) Dated January 25.

1199. "Electric telegraph and telephone conductors; laying, uniting, and securing same." D. NICOLL. Dated January 25.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

14216. "Lighting railway carriages and tram cars by electricity." C. SMITH. Dated November 20. The inventor attaches to the axles of the ordinary wheels a small wheel and chain driving an apparatus in connection with a dynamo, with appliances for lighting the whole or any number of carriages. The claims are 2 in number.

14837. "Improvements in ships' telegraphs." O. WHITE. Dated December 3. 8d. Consists essentially in combining with telegraph signal and return signal apparatus of any usual or ordinary construction appliances so connected to the reversing gear, or like part of the engine, by means of a catch, clutch, or other suitable device, that the return signalling apparatus cannot be actuated except to a limited extent without first giving the requisite motion to the reversing gear, or like part, and at the same time motion given to the said reversing gear will actuate to a limited extent the return signalling apparatus. The claims are 3 in number.

14855. "Improvements in apparatus for indicating electrically the quantity or direction of flow of fluids, such, for example, as for indicating the rise and fall of water in reservoirs, rivers, or the like, for indicating the direction of wind, and for other analogous uses." J. SAX. Dated December 3. 8d. In a suitable casing is contained a shaft which projects from the casing and has a wheel or pulley over it over which is passed a cord or chain, to one end of which a float is attached which rises and falls with the water. To the other end of the cord or chain a weight less than that of the float is attached. This shaft has a wheel on it gearing with a pinion on a shaft which carries two pairs of arms or contact makers, which I will call for the sake of distinction the right-hand pair and the left-hand pair. One of the arms of each pair is in electrical contact with a boss mounted on but insulated from the shaft, and these arms are also insulated from the shaft. The others of each of the pairs of arms are insulated from those first-named, but are in electrical contact with the shaft. The pairs of arms are so arranged that when the shaft turns in one direction one pair of arms is turned with it and caused to complete an electric circuit from a battery. The other pair of arms is carried round when the shaft revolves in the other direction and similarly makes contact and completes an electric circuit, but the connections are so arranged that the currents caused by the contact of one pair of arms flow in the reverse direction to the flow of the current caused by the contact of the other pair of arms. There is a train of wheels and a dial and pointer for indicating the revolution of the shafts due to the rise of the float with the water when the shafts turn in one direction and complete the circuit for a current of one kind and to the fall of the float as the level decreases when the shafts turn in the other direction and complete the circuit for a current of another kind. The currents thus generated are led to any suitable place where an indication is needed, and at such place there is provided an indicating dial with a pointer working in accord with those of the first apparatus. The indication of this second pointer is obtained by the currents from the first apparatus being led around electro-magnet coils mounted upon one end of a permanent magnet, upon the other end of which is a polarised bar working between the cores of the coils and attracted in one direction or the other in accordance with the direction of the current from the first apparatus. The said polarised bar in its movement in one direction acts upon a pawl or the like to turn a star wheel in one direction, and in the movement of the said bar in the other direction it acts upon another pawl or the like to turn the star wheel in another direction. The shaft of the star wheel is connected to the pointer of the dial by gearing to give an indication corresponding to that of the first apparatus. When the apparatus is used as an indication of the direction of the wind or the like a vane will take the place of the wheel or pulley described as being acted upon by the float and weight. The claims are 5 in number.

15277. "Improvements in electric locomotives." R. R. HUTCHINSON. Dated December 12. 1s. 1d. Relates to the construction of an electric locomotive in such manner as to effect the traction of ordinary railway trains, tram cars, and the like. The locomotive can be actuated from any source of electricity such as batteries or accumulators carried by it, or by special tender, or it can receive the current from a generating machine situated at a fixed point by means of contacts which move along supply and return conductors arranged along the way. The rails being capable of being utilised as return conductors, or the conductors can be arranged in the centre of the road and the current collected in the manner usual and most convenient. The electric dynamo, or electric motor, is arranged in such a manner as to develop as great a power as possible for a given weight, which is necessary for obtaining a good tractive power. It is important that it should develop this power by turning with moderate velocity so as to be able to work the driving wheels by the intermediation of gearing, both single, compound, and multiplying, this gearing working in direct connection with the driving wheels, which have cast upon them gear wheels. The inventor may also use friction wheels and rope gearing, with various multiplying powers working in connection with the geared driving wheels of the locomotive, in which case the electric motor will be fixed horizontally. The claims are 18 in number.

1886.

611. "A secondary voltaic battery." O. IMRAY. (Communicated from abroad by A. Khotinsky, of Rotterdam.) Dated January 14. 8d. Claim:—A secondary voltaic battery consisting of cells, each of which is a shallow box or tray of wood or other like material lined with bitumen or equivalent substance and sheet lead, and contains parallel shallow troughs of insulating material in which are laid skeleton metallic frames all connected at one end to one terminal of the cell whilst the other terminal is connected to the lead lining, the skeleton frames and the spaces between the troughs containing them being charged with the elements of the battery and the exciting liquid, substantially as described.

CORRESPONDENCE.

Secondary Batteries.

Those who, like your correspondent "Acid," make attacks upon others behind the shield of an anonymous signature and who consider that abuse suffices for argument, place themselves without the pale of consideration, and were it not for public interest in this discussion I should in no way notice such an effusion.

With regard to Mr. Desmond Fitzgerald's letter which follows it, I have reason to believe, although not having the pleasure of his personal acquaintance, that he will be the first to regret, when he knows the facts, having committed the gross injustice of writing as he has of my patent of December, 1881. Even at that early period in the development of secondary batteries, I was not conducting my experiments on a laboratory scale with a few ounces of material, but I was expending many thousands of pounds in working out the problems involved, and it may surprise him to know that I had in work and preparation at that time many tons of plates of almost every conceivable kind and combination, and amongst them large quantities of solid peroxide and spongy metallic plates of different forms, mounted and connected in different ways, several hundreds of which were of solid peroxide with thin perforated platinum foil embedded in them and platinum connections mounted in supports of paraffined wood; of these plates made in November and December, 1881, many still exist, although the bulk of them have been long since broken up to remove the platinum foil used (some hundred ounces or so), and I fully believe that these plates made at that early date will, from their special construction, give better results than the plates *at present put forward by the Union Company*. My records will prove also my employment of various mixing ingredients (amongst them the salts of soda, magnesia and ammonia) and also of my trials of fixing the surface of plates by dipping them in a mixture of glycerine and water. It must be remembered that I was pursuing the work with a determination to succeed, and that I was fortunate in having ready to my hand almost every known chemical and metal, and at my command an establishment unique as to its facilities for all chemical, metallurgical and mechanical work, at which I had occupied myself for thirty years.

The term "fishing" or "dummy" patent is so offensive, so uncalled for, and so unjust, that I am obliged reluctantly to ask your space for this personal explanation. I will venture to prove that I had at that period done as much real work in making and testing peroxide plates as, to judge from known results, has been accomplished in the five years which have since elapsed.

The effect of the garbled extracts of my patent unfairly given by Mr. Fitzgerald in order to make a point, is I am glad to say, counteracted by the publication in extenso of my specification, and his hypercriticism, not to say disingenuousness, in dealing with the word cellulose, the base of celluloid (a term, if I mistake not, scarcely in vogue at the date of my patent), will be nullified by reference to his partner's preliminary specification, No. 5,045, *1885*, in which the word cellulose appears alone, although altered to celluloid in the final.

To briefly recur to "Acid's" communication. He suggests my having failed in my attempts with peroxide plates six years ago. This is so, but not in the sense he insinuates. I *succeeded* in obtaining results which, as to efficiency and temporary working, fully realised my anticipations—results certainly better than can be obtained from the sample I have seen of the Union Company's plate. *The failure was, as it will be with those now put forward*, to obtain plates which are permanently efficient and which, in combination with their platinum attachments and celluloid frames, can be produced by any possibility at a price which can compete with those now upon the market. Such are the reasons which stayed my work in that direction, reasons which exist to-day as they did five years ago, and which I fully believe cannot be gainsaid or overcome.

My experience of such plates as those now put forward is that they gradually, sometimes rapidly, deteriorate, *unless kept charged to an extent which may bring about disintegration*; the interior, except where in close contact with the platinum, gradually becoming sulphated up and then only performing the function of a support for the outer layer of *acting* active material, with the disadvantage of being practically useless as a conductor.

"Acid" sneers at me for not having seen his battery cell. It is not my habit to pry into other people's premises and business; but, if report is correct, he and his *confrères* have taken the utmost precautions that their plates shall *not be seen or their exact nature known* to outsiders. My reference to zinc, which elicits another sarcastic remark, should be considered a saving clause as to the sanity of those who put forward the system proposed, for no one who has studied the subject could conceive such madness as carrying about the hydrogen elements of spongy metallic lead in a dry state, which, despite his disclaimer, is what the printed programme of the Union Company sets forth in these words:—

"In the system initiated by this company *only the elements* of the battery, not the weighty box and *fluid*, need to be transported."

And now with regard to this "system," which certainly has a taking sound to the uninitiated. I wonder whether it has ever occurred to any of the directors of the Union Company to inquire as to what it involves? I will attempt to give them an idea:—

Assuming that the company is going merrily along, free of all patent rights, and having after a time secured a clientèle of, say, a thousand customers, each using fifty 50-watt lamps for an average of six hours per day, within a radius of ten miles of their factory—not a large amount of custom for a company with half a million capital. Granting the capacity *claimed* of 5 ampères per lb. of battery plate, the figures would show roughly as under:—

Net weight of plates to be carted out and placed in position per day, about ...	700 tons.
Or with frames, cases, packing and acid, per day, say ... ... at least	1,000 „
The same weight of discharged plates back to factory making manipulation and cartage of per day, say	2,000 „
Number of two-horse vans necessary per day, say	350
At a cost of, say, per annum	£80,000
Permanent out-door staff, three men per van = 1,050, wages, say, per annum ...	£65,000
Recharging at factory 700 tons of plates per day, needing some 20,000,000 watt-hours, cost, say, per annum	£50,000
Renewal of worn out and spoilt plates with new once in six months (I question if under such usage they would last anything like that time) ... ... about	£140,000
One day's reserve of plates must be kept ready in stock, making a minimum rolling stock for 50,000 lights of one set in work, one set carting, one set charging, and one set reserve = 2,800 tons, representing a locked-up capital in these plates alone of about	£280,000

Electrolyte.—The removal of the discharged plates from the cells means the abstraction with them of a large percentage of the sulphuric acid, necessitating the addition of acid every day, and, to ensure even work, the regulation of the specific gravity of each cell.

The statement set forth is that the light, and, therefore, this work, will only cost $\frac{1}{16}$d. per lamp hour of 30 watts, equal to £50,000 per year for the 50,000 50 watt lights!!

The replacement of the plates means the invasion of private premises every day by a gang of strange workmen carrying heavy weights and acid solutions, and the placing in position of some million and a half of plates, displacing an equal number; and what about Sundays!

These very rough figures, absurd as they may appear, are, as to cost, far below what would be experienced in practice.

John S. Sellon.

January 22nd, 1887.

I notice in last week's issue of the ELECTRICAL REVIEW a note from Mr. W. J. S. Barber-Starkey on the use of a sodium compound in secondary cells, which that gentlemen has found of considerable value, and as I have had the pleasure of seeing the result of his experiments, you will perhaps allow me to offer a few remarks theron.

Nine months ago Mr. Starkey showed me two 15-L glass E.P.S. cells which he had treated in the way described. The plates certainly presented a beautiful appearance—the negatives displaying a blue black surface and a rich dark brown underneath, while the positives were well reduced. My attention was afterwards directed to the cells of his electric light battery. The contrast was great. Never before had I seen all the plates of such a battery in action so closely resemble in colour a damp white-washed surface. I cannot say what the whitish compound was, it may have been a mixture of lead sulphate, lead hydrate, and sulphates formed by the use of hard water; however, whatever the substance was considerable pressure had to be applied while scraping the plates with a piece of hard wood before even a small portion could be removed from any one of the plates. I was told that the two good looking cells which had been previously shown to me were in the same state as the cells of the battery before carbonate of soda was added to the dilute sulphuric acid, and that the same charging current had been passed through them. In my presence Mr. Starkey put about three double handfulls of carbonate of soda into one of the defective cells, and a few days afterwards (May 1st) he wrote to say :—"I have run the engine all day and every day since you left, having put into the cells between 400 and 500 ampère hours, but yesterday there was no apparent difference in the appearance of the plates except in the cell to which we added carbonate of soda, and in this cell the peroxide plates were beginning to present a beautiful dark brown appearance. I then added a little carbonate of soda to each of the other 19 cells, and finding that the E.M.F. did not appear to fall I was encouraged to add more, so that now all the cells contain a considerable quantity of carbonate of soda. Apparently the resistance remains the same, at least the dynamo gives the same charging current of 10 ampères. A few lamps used last night burnt very brightly, certainly, if anything, better than they had ever done before . . . . the (peroxide) plates in all the cells are now becoming a beautiful dark brown very rapidly, and I anticipate in another day's charging they will be in appearance all that could be wished. The tops of the plate first becomes dark brown, and then the dark brown colour descends, the bottoms being the last to change colour."

"May 3rd.—I write a line to say that since adding the carbonate of soda and charging yesterday the dynamo, the plates now present a most beautiful appearance. The peroxide plates are uniformly over their entire surface a very dark brown, almost black, and the + plates look like clean new metallic lead."

The addition of carbonate of soda to dilute sulphuric acid may produce sodium sulphate or bisulphate of sodium according to the quantities used, hence it was very gratifying to find that Mr. Swinburne in his recent paper on secondary batteries, read before the Society of Telegraph-Engineers and of Electricians, confirmed Mr. Starkey's practical application. Mr. Swinburne said :—"Even such salts as sodium sulphate dissolve some lead sulphate. This property is important in connection with ordinary secondary batteries. A little sodium sulphate mixed with the acid may tend to make the sulphate of lead more easily reduced; as, when all the sulphate is reduced that is in contact with the support, hydrogen is evolved and caustic soda is formed in the immediate neighbourhood of the plate and can dissolve the sulphate, the lead being then precipitated as spongy lead. The spongy lead can then make contact with the sulphate."

In chemical formulæ I understand Mr. Swinburne's suppositions to be :—

$$H_2 + Na_2SO_4 = H_2SO_4 + Na_2$$
$$Na_2 + 2H_2O = 2NaOH + H_2$$
$$2NaOH + PbSO_4 = Na_2SO_4 + Pb(OH)_2$$
$$Pb(OH)_2 + H_2 = Pb + 2H_2O$$

Since Mr. Swinburne says "a little sodium sulphate mixed with the acid may tend to make the sulphate of lead more easily reduced," and since Mr. Starkey does not convert the whole of his dilute sulphuric acid electrolyte into a solution of sulphate of sodium, I take it that sodium bi-sulphate ($NaHSO_4$) is the compound formed, and if so, this acid salt would, it seems to me, have a greater reducing effect thus :—

$$H_2 + 2NaHSO_4 = 2H_2SO_4 + Na_2$$
$$Na_2 + 2H_2O = 2NaOH + H_2$$
$$2NaOH + PbSO_4 = Na_2SO_4 + Pb(OH)_2$$
$$Pb(OH)_2 + H_2 = Pb + 2H_2O$$

Be this question as it may, what I desire for the present to urge is that where lead plates in dilute sulphuric acid cells are badly sulphated, a simple remedy for expediting the reduction of the lead sulphate without fear of buckling the plates or want of long charging with about half the maximum current rate, has been brought before us by Mr. W. J. S. Barker-Starkey and Mr. Swinburne. I beg, however, to state that I believe Mr. Starkey told me that he had been in the habit of using carbonate of soda in experimental secondary cells during the last five or six years, and had always found it to answer his purpose admirably. He being in a country place justly felt that electric lighting was of little gain if secondary cells could not be relied on to light up a few lamps satisfactorily each evening for two or three hours without being obliged to run the engine and dynamo every day for several hours. Then there was the unpleasant thought of his plates getting worse and worse when absent from home for a few weeks, and probably a much earlier collapse of the battery than should occur, hence he was prompted to renew his already tried carbonate of soda, and I am inclined to think the experience he has given us will tend to raise the hopes of other users of secondary cells similarly situated. I do not wish to enter into the efficiency of secondary cells containing a solid dissolved in the sulphuric acid electrolyte, but I may imply that although the resistance per cell may be more variable than in the case where the ordinary sulphuric acid electrolyte is used alone, still if the plates in the latter instance be perpetually sulphated, surely the lesser of the two evils is the best, and this seems to be, by Mr. Starkey's experience, in favour of the solid plus dilute acid.

I. Probert.

January 24th, 1887.

I beg to thank you for finding room in your valuable paper for my experiences with storage cells.

I regret extremely that I am unable to tell you whether the internal resistance of the cells is increased by the addition of the carbonate of soda, as I am not able to take an accurate measurement at present; besides, having put carbonate of soda into all the cells, I have not one containing simply dilute acid to compare with.

The current given by the dynamo through the cells was in no way altered by the addition of the carbonate of soda, so it would appear that the internal resistance of the cells was practically the same. The dilute acid was sent ready mixed by the Electrical Power Storage Company. The specific gravity of the liquid in all the cells is according to a hydrometer (also supplied with cells) 1,200.

W. J. S. Barber-Starkey.

January 24th, 1887.

Referring to "Acid's" statement in your last issue, that to those who know the *secret* there is no difficulty in "producing a plate which will have a capacity of 16 ampère hours per pound," I can assure him that there is no great secret in obtaining such results. It appears to me that the secret of producing secondary battery plates of great capacity, but with short life, is too well known, but the secret of producing a cell which has a large useful capacity, combined with a long life, has yet apparently to be discovered. If it is true that your correspondent can produce a cell which will have a *useful capacity* of 16 ampère hours per pound of Pb. combined with durability, electricians will be only too pleased to admit the great value of his discovery. However, a few months will doubtless put his statements to the proof.

H. A. K.

January 25th, 1887.

As a frequent reader of your journal, and one who, although not an electrician, takes a lively interest in inventions relating to the application of electricity to industrial purposes, perhaps you will permit me to join in the battle of the "elements" now raging in your columns between Mr. Sellon, on the one hand, and the Union Electric Light and Power Company and its coadjutors, on the other.

It appears to me that the advent of a new storage battery which bids fair to eclipse any battery made according to the patents of the Electric Power and Storage Company has the effect of completely depolarising Mr. Sellon, whose rate of discharge, judged by the letters which he indites to the papers, is so great, that he must inevitably run down very speedily. He was affected in the same way, if my memory serves me right, when he attacked the patents held by the Parker-Elwell Company about a year or so ago; but how that matter ended I know not. Perhaps Mr. Sellon will tell us?

However this may be, I think that in the present instance Mr. Sellon should treat your readers seriously, and that the public has a right to demand that this gentleman should endeavour to substantiate his allegations against the Union Company or withdraw them. As far as I have been able to ascertain, the Union Company has succeeded in producing a battery possessing very remarkable and novel features; and, if the opinions of the experts are to be relied upon, one that is destined to play an important part not only in solving the question of domestic lighting by electricity, but also in the manifold other applications for which a battery of this description is especially adapted. The notices of this battery in the Press seem to have excited Mr. Sellon, who, although so much interested in this question, has not, as he acknowledges, put himself to the very little inconvenience of learning how the battery is constructed by attending at the offices of the Union Company for the purpose of inspecting the battery, but has clutched at a statement in the Press that celluloid is used in connection with the elements, and upon this proceeds to build up a theory that the Union Company is poaching on the mine of wealth contained in that *omnium gatherum* document you were good enough to print last week (viz., the specifica- of patent No. 5,631, of 1881), because amongst the numerous other materials therein referred to he includes *cellulose*. In your same issue he attacks another of the patents held by the Union Company, without, apparently, having the faintest idea whether the Union battery is made in accordance therewith or not. There are none so blind as those who won't see, and it appears to me that Mr. Sellon's ignorance of the patents held by the Union Company is either due to this cause, or that he is trailing a herring across the path of the public. From information I myself have obtained at the Union office, I gather that the patents referred to by Mr. Sellon are by no means the most important which the Union Company holds. But, for the sake of argument, supposing this were so, how comes it that Mr. Sellon does not obtain, according to his old patent, and with all his experience and perseverance, the remarkable results achieved by the Union Company?

The public, I take it, are not concerned with the question whether Mr. Sellon can claim holes or perforations, or corrugations or roughened, indented, irregular or other surfaces, or "woven shapes" (whatever that may mean), but they are very much concerned with the question as to which battery is the best, and if Mr. Sellon means business, I would suggest that he should do one of two things, viz., either challenge the Union Company to a test, or else take a back seat. The public, I believe, is heartily sick of these squabbles, and has had altogether too much of Mr. Sellon's corrugations and holes and perforations. Is the march of science to be arrested because this gentleman presents a roughened surface? The vital question is, has the Union Company made a distinct and important step in advance, and is its battery capable of doing all that is vouched for it by the eminent experts whose opinions bear testimony to it?

I do not think it worth while to comment on the patents held by the Electrical Power Storage Company; but, again, if Mr. Sellon means business, will he produce the opinion of any well-known counsel or other person learned in the law of patents, to the effect that his patent which he cites (No. 5,631, of 1881), is *on its merits* a valid patent, and without giving attention to any embarrassing questions as to novelty, which questions might arise when his other patents come to be considered? If he can, then let him trot it out. If he can't, he will do well to give his active material a rest, and modestly accept the inevitable result of his unsupported statements.

Internal Resistance.

January 26th, 1887.

Referring to p. 50 in your last issue, will you allow me to state that the claim there quoted from a specification bearing my name in conjunction with that of Mr. T. J. Jones, refers to a method of constructing negative elements, which was superseded by other greatly improved methods, and did not therefore come into practical use.

I may further observe that a frame or edging of celluloid or other material is by no means a necessary adjunct to a "lithanode" plate, and that the mode of making contact with the *plate*, which involves the use of submerged binding screws of insulating material, would seem to be undeniably novel and original.

Desmond G. FitzGerald.

Walker's Sulphur Sal-Ammoniac Battery.

I am much obliged to your correspondents, Messrs. Barber-Starkey and Frederick Yorke, for their letters in your current impression. In reply to the former, we tried every combination of sulphur and carbon, and found the porous cell form gave the best results.

In reply to Mr. Yorke, my experience agrees with his. Manganese-dioxide has certainly a very high resistance, as I believe have most compounds of metals with other elements, in comparison with that of the metals themselves.

Sidney F. Walker.

The Union Battery.

In reference to the editorial questions in your last issue, I have much pleasure in answering them *seriatim* as follows:—

1. One of the first complete sets of batteries made has been in regular use during the last 10 months for lighting purposes at the offices of this company. Another battery was in use during six months at the company's works, at first for working 20 10-candle glow

lamps, and afterwards for working 36 lamps of the same construction. The same cells having been re-arranged, are now working two circuits together of 27 10-candle-power lamps at the offices of the "Union" Company in Cannon Street. Another battery has been in use during the last three months at the residence of H. Harker, Esq., 69, Gloucester Terrace, Hyde Park. I may further mention that we have a large number of plates which have been in use for various purposes for over 18 months; and these plates, as well as those in the batteries referred to above, show no signs of disintegration or deterioration; on the contrary, their capacity is slightly increased, their conductivity unimpaired, and they are as sound and hard as when first made. I need not here refer to the long continued laboratory experiments to test the durability of the plates and the increase of their capacity for charge.

2. The largest plate made up to the present time has a surface on each side of 56 square inches, and a capacity of 50 ampère hours.

We have found that after a little training, and with ordinary care on the part of boys and girls employed in the manufacture, *all* the plates made, with the exception of a small percentage broken by accident, are successfully converted into working battery plates.

3. Although the spontaneous evaporation of mercury at temperatures above 41° Fahr. is doubtless an experimental fact, it is at all ordinary temperatures so very slight as to be altogether negligible in practice. No strong current, *i.e.*, no current sufficient to appreciably raise its temperature is allowed to traverse the mercury. Means are available, when necessary, for preventing spilling, &c. It is unnecessary, however, to describe these, as the mercury trough is not essential, and is used only in one form of cell, since the plates can be connected in several other ways.

D. Armytage Davis, *Secretary,*
THE PRIMARY BATTERY CO.

Dynamo Regulation.

In your magazine for 7th inst., page 5, is an interesting paper on Prof. E. Thomson's new method of regulating dynamos, but I only now refer to it with regard to the plan of preventing *sparking* by the use of a *condenser*. I want to use a current of 60 ampères × by 60 volts from a dynamo for a special purpose, which requires the circuit of a coil to be rapidly closed and opened, which of course occasions considerable sparking, which I wish to obviate. Can you refer me to any description in your magazine or elsewhere which gives fuller particulars of this plan or any other for preventing sparking? or as to the nature of the effect of such a condenser, and further as to the size that would be necessary for the condenser itself for such a current as I mention passing through a large coil. I am acquainted with the general construction of condensers as used with the Ruhmkorff coil, but I do not clearly appreciate what becomes of the electric current that passes into such a condenser, as in the case described by Prof. E. Thomson. Is it *lost*, or does it go into the main circuit all the same without loss? If you can assist me to any fuller particulars I shall feel greatly obliged—or if you can give me your opinion as to the size of condenser, &c., would confer a great favour on an old subscriber.

Wm. Beatson.

January 22nd, 1887.

[Prof. Thomson will doubtless give our correspondent all the information he desires.—EDS. ELEC. REV.]

Sir Charles Bright's Address.

I did not have the advantage "A Dull Boy" had of listening to the presidential address, but having read it, I can more than agree with some of his remarks. The omission of Cromwell Varley's name from beginning to end is more than accident, for Sir Charles Bright knows as well as myself that Culley did not succeed Latimer Clark as engineer to the Electric Company, but Cromwell Varley, whom Culley followed. I am also surprised at no mention being made of F. C. Webb in connection with the first Atlantic cables, and astonished that his name is also omitted from the Persian Gulf expeditions, the success of which was mainly attributable to him.

Sir Charles Bright seems to have forgotten the experiments carried out in 1853 by Latimer Clark and W. H. Preece in the Electric Company's underground wires between London and Manchester which were witnessed by Faraday. These were, if I recollect rightly, anterior to those of Sir Charles Bright.

It does seem strange, however, that amongst the "names I cannot now call to mind," is that of Willoughby Smith, who of all others has played so important a part in the progress of submarine telegraphy. It seems incredible that the president never heard of Willoughby Smith's improved core and of his method of testing.

There is very much that is interesting in the address, and perhaps new to some, but surely we could have dispensed with the immortal "Kwaker." A sketch of Sir Charles landing the shore end at Fao would have been more interesting, as it is not known to the many.

Manchester.

Accumulators in America.

I see under the above caption, in your issue of December 31st, just received, among Notes (p. 647) that Mr. Vail is credited with being the owner of exclusive rights in the United States "of the patents for accumulators of Faure, Volckmar, Sellon, Swan, and others."

All the patents for accumulators in the United States of Camille A. Faure—except one, assigned to the Light and Force Company of New York—being my property, I do not see how Mr. Vail or any other person can have acquired the same, as I have not sold them to him or anyone else.

I call your attention to the fact that, if the United States patent of Swan is valid, it anticipates that of Sellon, while the Volckmar patent is so subordinate that its existence is immaterial.

Doubtless something considerable will be done this present year in this country by the accumulators as you say, but not exclusively by Mr. Vail.

The employment of Mr. Camille A. Faure by the Electrical Accumulator Company of New York (an offshoot of the Electrical Power Storage Company of London), of which Mr. Theo. N. Vail is president and promoter, I do do not see has any bearing on the matter—his good services to his employers is a private consideration between them.

John M. Pendleton.

January 14th, 1887.

The Lighting of "Olympia."

I have just seen in your issue of January 14th, an account of the electric installation at Olympia. I think that your representative has been slightly misinformed on some points.

There are and have been for the past month or two from 85 to 90 Brush arc lights, not 60, as a temporary installation. The incandescence lamps are to give 17 C.P. at 65 volts, not 60.

The arc lamps in the great hall are 54, not 58, being nine groups of six in each group.

As the installation is not yet complete, the electrical portion of it is still in the hands of the Brush Company and is worked by them, and will be till it is handed over to the Olympia Company. Any credit, therefore, that there may be is due to the Brush Company, and not to Mr. A. H. Wood, who is not yet in charge of the installation.

F. H. Shipton,
Anglo-American Brush Electric Light Company, Limited.